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The
GEOGRAPHICAL JOURNAL

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ACROSS THE EMPTY QUARTER

W. THESIGER

Evening Meeting of the Society, 20 October 1947

STARTING FROM SALALA on the Arabian Sea in October 1946, I travelled until May 1947 across the Rub' al Khali to the settlements at Liwa near the Trucial coast, then back to Salala by the steppes of western Oman and the Jaddat al Harasis, and from there through the northern Mahra country to Mukalla (maps following p. 152). This journey of 2000 miles was undertaken for the Middle East Anti-Locust Unit and continued the investigations carried out during my journey in 1945–46, described in the *Journal* published in April 1947.[1] It was through country not as yet visited by any European, except between Baï and Salala and Salala and Mughshin where Bertram Thomas had travelled in 1928 and 1929. Bertram Thomas and Philby, the only two Europeans who had previously crossed the Empty Quarter, had travelled 200 miles and more to the west of my route. Bertram Thomas discovered a well-watered route across the central sands by Dakaka to the Qatar peninsula, which is the one the Badu use when they cross the sands, while Philby had travelled still farther to the west and had finally reached the wadi Dawasir. Nothing therefore was known of the eastern sands except that the Badu believed them to be waterless and to consist of mountainous dunes.

It was the eastern sands and the unknown steppes of western Oman which I hoped to explore but I had only asked permission to revisit the Mughshin area and the preparations which I could make in Salala were consequently limited. The Wali insisted that I should take with me twenty-four Arabs to be selected from the five sections of the Bait Kathir and from the Rawashid, far too big a party for my purpose. Among those who came with me were Shaikh Salim Tamtaim; Sultan, Shaikh of the Sha'sha; Musallim bin Tafl, Shaikh of the Masaliha, and others who had been with me the previous year. To add to my difficulties their camels were in poor condition after a year of drought, fit enough perhaps for a journey to Mughshin but not for crossing the sands.

I provided my party with 2000 lb. of flour, 500 lb. of rice, samn (liquid butter), coffee, tea, sugar, and some dates [2] and warned them that we should

[1] "A new journey in southern Arabia," *Geogr. J.* 108 (1946) 129–45.

[2] Although the seashore at Salala is fringed with coconut palms there are no date palms in Dhufar. The dates begin to arrive by dhow from Oman and Basra when the winds change at the end of December.

be away for three months and that this must suffice. I realized however that a large part of these rations would be left with their families and that, half starved as they were, they would show little restraint in consuming the remainder, trusting to Providence to provide them with more when it was finished; so I retained a small reserve for feeding guests and for emergencies and divided the rest among the groups in which we were to feed.

We left Salala on October 25,[1] crossed the Jabal Qarra by the Kismim pass, watered at 'Uyun and again at Ma Shadid, and from there followed the wadi Ghudan to Shisur well, where we arrived on November 6 and were joined by Salim bin Kabina, a Bait Imani lad of the Rawashid who had been with me the previous year. With him were Muhsin bin Khuzai, a Bait Imani Shaikh, and Muhammad al 'Auf, another of his tribe. Muhsin had been grievously wounded in the thigh by raiders two years before but, since he was a Shaikh of consequence and an old friend, I included him in our party; also Muhammad whom I did not know but whose reputation as a guide stood high. We crossed the bleak desolate steppe to the Umm al Hait and then followed this wadi's southern branch, the Bin Khautar, to Mughshin which we reached after eight waterless days. As we approached the well our camels stampeded and Muhsin was thrown heavily, smashing his femur in several places and reopening his old wounds. I gave him morphia and after setting his leg made him as comfortable as possible by having a shelter built for him under a ghaf tree.

During the journey I had gradually accustomed my companions to the idea of travelling farther with me, either on to Umm al Samin or to the north. After much discussion they preferred to travel north with me into the sands rather than to visit the Duru' territory to the east, for this tribe are Ghafiriya whereas they themselves are Hanawiya.[2] They remembered the rewards which I had given to some of them the year before and the hope of earning more was a strong inducement to please me. Muhammad al 'Auf and Bin Kabina were coming with me, but all the other Rawashid were remaining with Muhsin since they feared that the Sai'ar or Karab would try to kill so redoubtable a foe should word of his accident reach them through some passing Arabs. This was unfortunate, for the Rawashid are at home in the sands whereas but few of the Bait Kathir other than the Bait Musan ever enter them, for they dwell in the Najd [3] and steppes to the south. Sultan, Musallim, and

[1] The Rawashid and Bait Kathir use different words for the seasons, which is often confusing. Rawashid: Saif or Hamim, April–June; Kharif, July–September; Shita, October–December; Rabi', January–March. Bait Kathir: Saif or Gaidh, April–June; Kharif, July–September; Sarab, October–December; Shita, January–March.

[2] For the distinction between Ghafiriya and Hanawiya see *Geogr. J.* 108 (1946) 131.

[3] The inland slopes of the central range are called Najd whereas the slopes draining to the sea are called Shazar. The Qatan is the level ground along the summit of the mountains. The steppes between the Najd and the sand to the west of the wadi Katibit are known as Saih (pl. Suyuh), while the more barren plains east of the Katibit as far as the foothills of the Oman mountains are called Jaddat. Throughout this paper I have used Rub' al Khali (The Empty Quarter) to denote the great desert of southern Arabia, for it is by this name, given to it by the settled Arabs and Badu of the north, that the outside world know it though the Badu who live in it have never heard the term. They call the sands collectively Al Raml. It would be difficult to define the limits of the Empty Quarter since the steppes are more waterless and barren than much of the sands, certainly more so than Ghanim, Dakaka, or Hibak, whilst the salt flats of the Hiqaf are a veritable waste of desolation.

Mabkhut bin Arba'in, Shaikh of the Bait Gidad, and three of the other five who had agreed to join us had been with me the year before in Ghanim and Sahma. This however was their only experience of the sands.

We planned to cross the Rub' al Khali from Ghanim to Dhafra,[1] to water there, and then to buy food at the settlements at Liwa before turning east to the wadi al 'Ain. Meanwhile the remainder of the party under old Salim Tamtaim were to cross the Jaddat al Harasis to Baï, near the southern coast, and to wait for us there. We hoped to join them in two and a half months' time. My apprehension about our food supply was justified since the greater part of our store was already gone and from what was left I had to supply Muhsin and his Rawashid, also those of my party who had been feeding with me and were now returning to Baï, as well as the ten Arabs who were crossing the sands with me.

We left Mughshin on November 24 and watered at the well of Khaur bin 'Atarit in Ghanim on the 29th. The sands here were barren, the grazing of the previous year having disappeared, so that our camels started hungry on their long journey. Ahead of us were some sixteen waterless days and we filled every available skin with the bitter water tasting foully of magnesium sulphate. But by using water to wash before prayers on the first evening the Bait Kathir showed that they little realized the severity of the journey before us although they have a saying "as far as Dhafra" to indicate the *ultima thule*. When I remonstrated, telling them that the wells at Dhafra were nearly twice as far from here as was Salala, Sultan remarked gloomily that if that was so neither we nor our camels would ever see them. We counted on coming across some Rawashid and Bait Musan herds in Ramlat al Ghafa with whom we could change our weakest camels, and were soon encouraged by finding their ten-day-old tracks which we followed in a north-east direction. We made good progress across successive desolate, crystalline, salt flats (sabkha) enclosed by dune masses 300 to 400 feet in height. They were of a rich red gold, veined with silver and very lovely, but devoid of vegetation other than a few patches of 'arrad and shinan.[2]

It was soon apparent that the Bait Kathir, and in particular Sultan, were losing their nerve. Our water was dangerously short and they were lost and bewildered among these great dunes, unable to distinguish one from the other and dismayed by the increasing weakness of their camels and by the continued lack of grazing.

On December 2 we reached Ramlat al Ghafa where we soon sighted a small herd of Bait Musan camels; they were however in poor condition and the herdsboy told me that the Rawashid herds nearby were in no better state. I therefore proposed that four of our party whose camels were exhausted should return to Mughshin with a Bait Musan guide. Sultan at once declared that we were already too small a party, that there was danger ahead of us from raiders and that we must either all go on or all go back. In fact they were

[1] The southern Badu pronounce Dh as L, hence Dhafra as Lafra. They also substitute Y for J, hence Liwa is for al Jiwa = al Yiwa.

[2] The following are salt bushes: yaqawa (*Halopeplis perfoliata*), hardan (*Suaeda* sp.), rimth (*Haloxylon salicornicum*), tahyin (*Salsola Bottae*), 'arrad (*Salsola cyclophylla*), kakabit (*Salsola leucophylla*), hamala (*Salsola* sp.), shinan (*Seidlitzia Rosmarinus*), hadh (*Cornulaca monacantha*), niqawa (*Anabasis setifera*).

determined to go back, the Bait Musan herdsboy having added to their apprehension with a tale of some Arabs who had perished last year in attempting to cross these sands although they had been well mounted and well supplied with water. After much discussion I asked al 'Auf and Bin Kabina if they would come on with me. Both agreed at once and Musallim volunteered to come with us, and he was later joined by Mabkhut bin Arba'in. We divided the food and water, taking as our share 40 lb. of flour, a pint of liquid butter, some sugar, tea and coffee, and four skins of water. We now lived on bread baked in the embers of the fire and lightly smeared with butter, which we divided into five portions each evening, casting lots for them as is the custom among these Badu. We fed but once a day at sunset. Our water was only sufficient for a daily allowance of two pints each, which we drank mixed with some sour milk [1] given to us here by the Rawashid. This improved the taste of the Ghanim water, which each day became more brackish and foul tasting. Bin Kabina's camel was in milk and yielded a small but decreasing amount daily. He milked her into a woven grass bowl kept for the purpose, for the Badu avoid if possible milking into a bowl which has been used for food, especially for meat or butter. They believe that a camel will go dry if milked with unwashed hands or into a dirty bowl, and if short of water they wash their hands under a staling camel since they do not consider it adequate to rub them with sand. Women may never milk among the Rawashid or Bait Kathir.

Ramlat al Ghafa was very beautiful. The great dune masses 400 to 500 feet in height were of a rich warm red, shot with silver and gold and dotted with clumps of yellow flowering tribulus and the bright green of the abal bushes (*Calligonum comosum*). The hollows were filled with zahra (*Tribulus macropterus*), alji (*Dipterygium glaucum*), birkan (*Limeum indicum*), qasis (*Cyperus conglomeratus*), and a little rimram (*Heliotropium persicum*) from which larks rose in song. This herbage was a result of the heavy and widespread rains in 1944.[2] The Arabs divide the sands into "red" and "white" and say that the red give better and more lasting grazing than do the white.[3] Al 'Auf had crossed

[1] These Badu subsist almost entirely on camels' milk, seldom eating solid food. When travelling away from their herds they carry milk in skins, drinking it mixed with an equal quantity of water and replenishing the skin with water after each drink, with the result that the milk gets more and more diluted. Milk mixed with water is called shinin, and water even though undrinkably brackish can be drunk like this.

[2] See *Geogr. J.* 108 (1946) 134.

[3] Muhammad al 'Auf listed the sands which provide the best grazing after rain as follows: Dakaka, Khilla (between Dakaka and Hibak), Qa'amiyat, Dhafra, Bainuna, Taff (sandy section), Ibn Sa'dan, Hawaya. Dakaka is much the best grazing area and the vegetation there will remain green for three or even four years after rain. Grazing grounds are referred to as ramla, sterile dune areas as shuquq or 'uruq, and the salt flats as sabkha or mesabikh. The red colouring (among the larger grains) is due to iron oxide and the green tint (among the smaller grains) to glauconite.

Vegetation other than a few species of salt bushes (harm, shinan, hadh) is absent on the salt flats and confined to the higher areas. This is undoubtedly due to the concentration of soluble salts on the sabkhas being too high for most plant growth. Analysis of this salt shows an impure common salt containing a fair proportion of calcium and magnesium sulphates. Little appears to be known concerning the concentration of salts in the moisture films surrounding sand particles in the different types of sand which support vegetation. All that can be said at present is that the sands which support the

the year before with a small party from Dhafra scouting for pasturage and had later returned alone, a ten days' journey through the overwhelming solitude of a dead world. He had found a few small patches of grazing and he hoped that a light shower in this area in March 1946 might have produced a little fresh vegetation. I was lucky indeed to have encountered him since seldom do Arabs cross these mountainous, waterless, eastern sands, using instead the easy and comparatively well-watered central route by Dakaka and Hibak.[1]

We lingered for a day in Ramlat al Ghafa to graze our famished camels. In such areas shortage of water forbids unnecessary delay, yet the growing weakness of the camels necessitates a halt whenever pasturage is encountered. These Badu will always risk their water running out in order to spare their camels since they reckon that in winter they themselves could last for a week without food or water by which time, provided their camels did not collapse, they would almost certainly have reached a well. Hunger never presents them with a serious problem for in the last resort they could always kill and eat one of their mounts. I found that in winter they preferred thirst to hunger. They will eat hares, wild cats,[2] foxes, fennecs, hyaenas, which they call the prophet's ram, hedgehogs, jerboas, jirds, skinks, lizards, and eagles. Yet they are disgusted when they hear that the Junuba and Wahiba eat the wild ass.

From Ramlat al Ghafa we travelled north-west through mountainous dunes interspersed with white salt flats. Our five riding camels were from the steppes and these steep climbs and long slithering descents frightened them. Once one of them carrying our water-skins collapsed and, attached to the camel in front, was dragged over on to her side. Mercifully the skins were undamaged, but we had been badly frightened and loaded them in future on our spare camel, a powerful black bull bought in Ramlat al Ghafa and bred in the sands. The moon was young and we travelled on through the first half of the night, our camels stepping out into the cold across the crackling salt flats beneath the dimly seen, unreal sand dunes, encouraged at times by the full throated roaring of Arab war songs. Beyond Sabkha Takha we came to the 'Uruq al Shiban, a rose red, mountainous range of sand, very lovely in the

best and most long-lived vegetation are rich in calcium and glauconite, a mineral which contains potash. I noticed particularly that tribulus and heliotrope did not flourish together in the same area. Sahma produces a large amount of heliotrope and practically no tribulus, whereas the sands of Ghanim and Al Ghafa produce much tribulus and practically no heliotrope. It is the tribulus-bearing areas that the Arabs value for grazing.

The fact that vegetation can survive up to four years after a single rain storm must be dependent on both the capacity of the plants to survive on a very meagre water supply and on the fact that all rain which does fall penetrates at once so deeply into the sand that subsequently little of it is lost by evaporation. The water will be lost rapidly from the upper layers of sand into which the heat of the sun penetrates, but at greater depths where the change in temperature is small evaporation will be slower than in normal soil. The Badu judge if a shower has been sufficient to produce valuable grazing by seeing whether it has penetrated the sand to elbow depth (see also *Geogr. J.* 108 (1946) 135).

[1] See Bertram Thomas, "A journey into Rub' al Khali," *Geogr. J.* 77 (1931) 1–37.

[2] In Ramlat al Ghafa an Arab gave me the skin of a Khawanja (*Felis ocreata*) which he had recently killed and eaten. They are said to be common here, as are foxes (tha'lab and fennecs (hirr).

light of dawn as it rose in jagged peaks and spurs 500 to 700 feet above the ice-coloured sabkhas. Unexpected cumulus clouds banked up at noon to add to the illusion that we were high among alpine peaks with frozen lakes of blue and green far below. Running north-north-east and south-south-west and only to be crossed in very few places, the 'Uruq al Shiban are almost certainly the highest of the dunes in the Rub' al Khali for they are reported to be higher than the western sands of Qa'amiyat. It was cold by day and bitter cold by night. We now travelled for two days between barren, sheer-sided dunes of yellow sand, across sterile salt flats whose crusts were cruel to our naked feet. We made good progress, travelling late into the night. Once we were halted by a total eclipse of the moon. My companions showed no uneasiness, singing:

Allah is eternal
The life of man is short
The Pleiades are overhead
And the moon among the stars.[1]

By now our camels were very thirsty.[2] Although they browsed on the succulent shoots of the abal bushes, they were too parched to eat the occasional tufts of dried qasis and zahra. Luckily we came on some fresh herbage springing from a shower in March and they greedily cropped the young shoots of qasis while we ranged far and wide to gather it in our cloaks for their evening meal. Camels, however thirsty, will recover condition without being watered if turned loose on fresh grazing.[3]

The mountainous sands were now behind us and we crossed the gentle downs of Ramlat al Kharfiya, coloured buff or green-tinted gold, changing abruptly and unbelievably in places to rusty red like dried blood, or to burnt sienna splashed with purple, and enfolding small snow-white pans of gypsum, ringed about with belts of grey-green shinan (*Seidlitzia rosmarinus*) or lime-coloured harm.

Here we met a Rashidi Shaikh, Hamad bin Hanna, who was looking for a stray camel and he agreed to come with us to Liwa. We heard from him that many of the Murra, Manasir, and 'Awamir were assembled in Dhafra and Rabadh for the yearly assessment of taxes. This was unwelcome news. If we

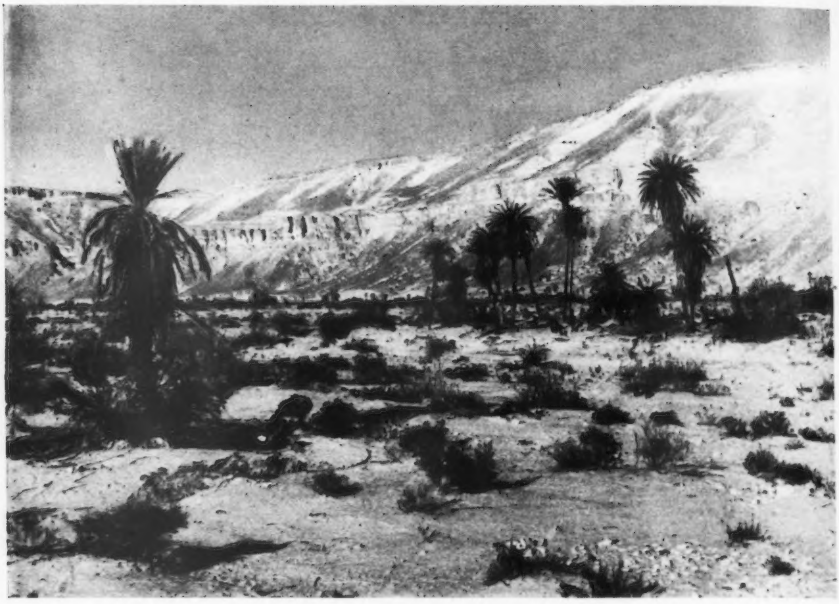
[1] Arabic version:

دائم الله دائم الله
بنى آدم ما يدوم
الثريا فوق الرأس
والقمر بين النجوم

[2] To revive a camel showing signs of great distress from thirst, pour a pint of water down its nostrils.

[3] Zahra is the best camel food in the sands and is especially good if mixed with abal, which quenches thirst but lacks nourishment unless mixed with other plants. Fresh alji, qarna, sa'dan, and qasis provide good grazing and anqud (the seed heads of qasis) is fattening but causes thirst. Rimram is good food and thirst quenching. Kariya and halima, found in the northern sands, are rated high as pasturage, while hadh and 'arrad are useful as a standby but cause thirst. Badu say it is bad for camels to graze on zahra and hadh together. Sand camels produce more and better milk than steppe or Najd camels.

Crossing 'Uruq al Shiban, highest dunes in the Rub' al Khali



Limestone cliffs of wadi Jiza

Wadi Kidyat, tributary of wadi Jiza seen above

encountered any tax collectors we should probably be taken to Hufuf to explain ourselves, since we were here without the permission of Ibn Saud, and delay in getting to Baï would start wild rumours, more especially after our desertion by the Bait Kathir. We decided in consequence to avoid all Badu other than the Rawashid, and that Hamad should go to Liwa to collect food for us while we lay up in the neighbouring sands. The Karab [1] had raided this area the year before and there was a real risk of our being mistaken for raiders since the tracks of our camels marked us out as coming from the southern steppes.[2] This risk would be increased if it appeared that we were avoiding the Arabs, for honest travellers would never pass by without exchanging the latest news. These Badu are consequently well informed of happenings inside their own world—the world of the great desert and its fringes, the land of the Murra, the Manasir, and the 'Awamir, the Bait Kathir and Rawashid, the Mahra, Manahil, Nahd, Karab, and Sai'ar, the Abida and the Dahm, and to the east the Duru' and Junuba, the Wahiba and Harasis. Strangely familiar, by name at any rate, with many men of these other tribes they yet know nothing of events in the Oman mountains, in the Yaman, in the Hijaz, or even among the great Badu tribes of southern Najd, the 'Ajman, Mutair, 'Ataiba or Qahtan. Aware of every happening amongst the Manahil they have scarcely heard of the neighbouring Humum beyond wadi Masila.

Leaving the hard red downs of Ramlat al Hamrur behind us we arrived in the sands of Dhafra, and having watered our camels at the very brackish well of Khaur Sabkha, from which they would not drink, thirsty as they were, until we covered their nostrils, we arrived at Khaba well on December 13. We could now relax from the strain under which we had been living and rest our bodies, worn by the long marches. Secretly we had feared for days lest our camels, distressed by thirst and lack of grazing, should collapse or lest an accident or sickness should delay us. Only Muhammad had known the direction of our march and possessed the skill to keep it among the maze of dunes and to find a path for the camels up their steep faces. We had only guessed at the difficulties ahead of us while he had known them, but his quiet confidence had reassured and inspired us.

While there are numerous wells in Dhafra fit for camels, it is only from Khaba and Khaur Aqsa that the water can be drunk by the Arabs. There are however numerous drinkable wells in the Batin. We were now across the Rub' al Khali and amongst the wells and permanent grazing of hadh, shinan, and harm [3] on which the Badu fall back in a poor year. In general these sands are white although Ramlat al Hamra north of Rabadh is red. They vary

[1] The Karab are a Badu tribe living in the area of the Ramlat Sabatain west-north-west of the Hadhramaut, although a few of them are settled round Shabwa. They are noted raiders.

[2] For the recognizing of tracks see *Geogr. J.* 108 (1946) 136. Whenever we wished to avoid attracting attention Musallim and I rode, for Musallim, although a Badu, had lived for a long time in Salala and they said that this would be immediately apparent from his footprints to any Badu.

[3] The Manasir, 'Awamir, and some of the Duru' graze their herds on the harm and shinan salt bushes which necessitates their being watered at least once a day. This pasturage taints the milk and scours the camels so that their excrement is an ever-flowing liquid slush, but strangely enough they become very fat on it.

between rolling downs of hard sand (dakaka) interspersed with small sabkhas such as the sands of southern Dhafra and much of the Batin, and small adjoining crescent dunes of uniform size (rabadh) in northern Dhafra, Kidan, and Rabadh. It has been assumed that crescent dunes are always mobile but the hadh growing on these, particularly in the hollows, seems to indicate that they have been static for a considerable time.

On December 16 we stopped near Bir Balagh in the Batin on the southern edge of Liwa. From here Hamad and Bin Kabina went down to the settlements to bring us food. They reappeared on the evening of the 19th and we were glad to see them, having had no food for three days. They had not been very successful, returning with only 30 lb. of wheat grain and two small packages of very poor dates. In the three settlements which they had visited the Arabs had refused to accept their Maria Theresa dollars, demanding rupees, but had finally accepted a dollar at the same rate as a rupee.[1] We now fed on boiled grain savoured with dates pulped in water, an even less satisfying meal than the unleavened bread which had been our scanty fare since leaving Mughshin.

At Bir Balagh the altitude was approximately 550 feet. At Bir Sabkha I got a reading of 580 feet and for Mughshin an average of 650 feet. The floor of the eastern Rub' al Khali is thus a level sandy plain between 650 and 550 feet high, devoid of geographical features other than the great sand masses, which at their highest in the 'Uruq al Shiban rise 700 feet above the floor. The sand, which is of both the red and white types, lies throughout in great mountainous masses and nowhere south of Dhafra are there any true crescent dunes, although these dune masses tend to be very steep on one side, a characteristic of crescent dunes. I believe them to be static, retaining their distinctive peaks and pinnacles throughout the years. They are said to extend westwards to include Hibak, beyond which are the downlands of Dakaka, and to occur again in the western sands. Heavily salt-impregnated sabkhas, which are sometimes covered with a crust of impure common salt mixed with calcium and magnesium sulphate, surround the sand masses and are often very extensive, reaching long arms between the dunes. Salt water is to be found, generally at a depth of 3 to 7 feet, but nowhere east of Hibak nor between Ghanim and Dhafra is there water fit even for a camel to drink.[2] I saw a few small outcrops of the underlying Eocene limestone [3] between Ghanim and Ramlat al Ghafa where small fragments were scattered over the flats. On a previous journey I had noticed a number of such outcrops 4 to 8 feet in height in Shiqq al Sahma, and flint splinters on a sabkha in Ghanim. Otherwise I saw no rocks, stones, nor even gravel during the 450 mile journey between Mughshin and the Oman steppes.

The vegetation of the Rub' al Khali is very limited. Harm, abal, with zahra, alji, qasis, and birkan after rain, occur throughout the sands. Darma (*Fagonia parviflora*), rimram, qarn (*Monsonia nivea*), 'arrad, jithjath, and shinan

[1] In 1947 the exchange was about 16 rupees or 8 Maria Theresa dollars to the pound.

[2] There is said to be one well, Khaur al Naqa, fit for camels in Ramlat al Ghafa, but Muhammad al 'Auf failed to find it last year although he spent some time searching for it.

[3] See note on my 1945–46 collections by Dr. Campbell Smith, held by the Society.

are to be found as far north as Ramlat al Ghafa, while shinan occurs again to the north of 'Uruq al Shiban. Here too we first encountered hadh (*Cornulaca monacantha*) although the previous year we had found a little in Sahma.

Oryx, except for an occasional straggler from the south, do not occur north of Sahma and Ghanim and even there they are uncommon. Rim (*Gazella marica*) have practically disappeared in the past years, probably from disease, although I was told that a herd of fifteen had been seen in Dakaka during the previous year. The damani (*G. saudia*), common in the steppes and Najd to the south, penetrate occasionally into the Ramlat al Ghanim and Sahma where we saw a few tracks. Hares (*Lepus arabicus*) are common throughout the Empty Quarter, living in burrows generally shallow but sometimes as deep as 9 feet. Foxes, fennecs, and wild cats are sometimes to be found. Bird life is scarce. Ravens, accounted lucky if met with in pairs but unlucky if single, will follow travellers and are often to be seen flying across these empty wastes. Twice we saw tawny eagles and the year before a few kestrels in Sahma. Bifasciated larks and an occasional wheatear frequent any recent herbage.

Liwa, inhabited by the Bani Yus and Mazariya, extends approximately 30 miles from north to south and 40 miles from east to west. Such trade as exists is with Abu Dhabi on the Trucial coast, a journey of seven days. Settlements of crude frond shelters are scattered amongst numerous small palm groves under the dunes. There is no cultivation and in general the inhabitants appear to be diseased, squalid, and poverty stricken. They own small flocks of goats, some camels and donkeys, and a few salukis which they use for hunting hares on the surrounding sabkhas. A good saluki will catch six hares in a day and is valued at two camels.

We watered at Bir Balagh and then moved eastward through the Batin where occasional small groves of stunted palms struggled for life around the sabkhas. Each day we woke at dawn drenched with dew, often to find that the sands were shrouded in a dense mist [1] which lingered for three hours after sunrise and delayed our start, since we feared to come unexpectedly on Arab herds. While descending a sheer-sided dune our camels were frightened by a loud, ever-growing, vibrant hum, evidently caused by a layer of sand slipping down the face of the dune, which continued for several seconds after the last camel had reached the flat. This was the roaring of the sands, a sound we had heard once before when we halted on a still afternoon in the 'Uruq al Shiban. On that occasion it had lasted for nearly a minute.

In Rabadh we toiled across an endless sea of crescent dunes where Manasir and 'Awamir were grazing their camels on the hadh pasturage. While we four made detours to avoid them, Al 'Auf and Hamad rode over to them to ask news of the Rawashid herds. These we found next day near Bir al Tawil, and guided by one of the herdsboys we approached the Rawashid encampment where five Arabs stood up to receive us, holding their rifles. We saluted them as we drew near, and after greeting each of them in turn with the triple nose

[1] Here the wind was generally northerly. Round Baï in early February we had heavy dew with a southerly wind. In December 1946 there was a heavy dew and some ground mist in Sahma with a southerly wind, and there were soaking dews in January and February in the steps north-west of Dhufar also with a southerly wind.

kiss, sat down opposite them on the sand and waited until they asked: "What is your news?" to which we gave the formal answer: "The news is good." [1] Thus do the Badu always greet each other even if they have only parted for a few hours. They now made us coffee, the black bitter coffee of the sands flavoured with cardamum, and at sunset when the herds were driven in brought us great bowls of frothing milk, and feasted us that night on a young camel with the princely hospitality of the true Badu.

The Rawashid are a small tribe divided into the Musaifar, Mudairiba, and Bait Imani, numbering in all some 250 grown men.[2] They are the dwellers in the Empty Quarter. The Murra know the northern sands, the Bait Musan the wastes of the south-east, but the Rawashid graze their herds from Rabadh to Ghanim and from Dakaka into the steppes to the north of the Hadhramaut. They roam from Al Hasa down to Salala, from Najran across to the distant Wahiba country in south-west Oman and are to be seen in the markets of 'Ibri, Buraimi, and Abu Dhabi. Mubarak, our host's son, came on with us to guide us to the wadi al 'Ain. We camped that evening among the ghaf trees at the well of Qusaiwara (the first ghaf we had seen since leaving the Mughshin sands) and, passing Umm al Zamul well on our right, travelled down the long salt flats between chains of high golden dunes to the steppes of western Oman. We camped on a flat gravel plain in the imperceptible depression of a watercourse dotted with trees, and only the small isolated dunes of Kharima and Khiyut broke the horizon to the north and north-north-east. At sunrise a continuous, very high wall of sand stretched across our front from the north-west to the north-north-east. An hour later this reflection broke up from below and the dunes, after hanging for a space in the air, disappeared leaving only Kharima and Khiyut reduced to their proper size.[3]

The sporadic warfare of raid and counter-raid between Abu Falah of Abu Dhabi and Bin Maktum of Dubai had recently flared up again, unsettling the

[1] After this invariable question and answer, spoken by the two most senior Arabs present, the conversation becomes general, individuals greet each other and the latest information is exchanged. Dates and coffee if available are now produced, and the hosts eat a few dates and drink coffee with their guests. Coffee is flavoured with ginger in the south but in the north with cardamum. Sweet tea is a great luxury and much appreciated.

[2] The Bait Kathir number approximately 600 grown men (i.e. over fifteen years). The Dahdha sections: Bait Ghuwas 100; Bait Jidad 100; Bait al Hamr 60; Masaliha 200. The Shalahima sections: Sha'sha 70; Bait Musan 80.

[3] Lord Rennell writes of a similar experience in the Sahara: "In 1927, when crossing the Serir desert between Aïr and the Ifoghas n'Adrar, descending imperceptibly into the Tasellaman basin, one evening about four or five o'clock I saw what seemed to be a large, isolated, rocky massif far on the horizon where no rock outcrop ought to have been. My Tuareg guide was somewhat perturbed until he recognized it as a small "gara" raised (the right way up) above the horizon by a mirage effect. The Tuareg agreed that they had never seen that gara from so far away, estimating it at fully a day's march. They described the massif as an inconspicuous, flat-topped gara normally visible about two hours' march distant. I was later able to identify the landmark from such maps as existed, on the correct bearing and some 30 to 40 miles distant. The weather was hot and very still. The image remained visible for an hour or two. Next morning there was no sign of anything on the horizon." For an account of this journey see, "A second journey among the southern Tuareg," *Geogr. J.* 73 (1929) 1–19.

Bin Ghubaisha, our Rashidi hunter

Elderly Badu of the Rawashid

Crossing the barren steppes of Jaddat at Harasis

Ghanim dune, typical of the Rub' al Khali

tribes, and a large body of Bani Katab had passed westward to raid the Badu who supported Abu Falah. The Duru' were neutral, but my companions were apprehensive for this tribe is a traditional enemy of the Kathir. We arrived at Khaur Kadri, 710 feet above sea-level in the wadi al 'Ain, on January 3 and our reception by a small Duru' caravan using the well was tense and watchful. The small supply of grain bought in Liwa was nearly finished and we craved greedily for more substantial food after living for so long on one scanty, unappetizing meal a day. 'Ibri, governed for the Imam [1] by a Wali, was the nearest market and the Rawashid insisted vehemently that, if they were to visit it, news that I was a Christian must not get abroad, since otherwise the Duru' might chase us back into the desert or the Wali send soldiers to detain us. They declared that I was a Syrian travelling from Riyadh to visit the Sultan in Dhufar, silencing my doubts by saying that while the Duru' might have heard of Syria they would never have met a Syrian. We stopped in some small dunes near the well, close to the encampment of an elderly Dara'i called Saiyun,[2] whose son 'Ali accompanied the Rawashid next morning to 'Ibri. The dunes and bushes hid me at the hours of prayer and the excuse that I was suffering from fever avoided unnecessary contact with our occasional visitors.

The Duru', whose head Shaikh is Muhammad Tina bin Sa'id, are a powerful tribe living in the foothills and steppes of western Oman between 'Ibri and Dam, but they never enter the sands. Allied to the even more numerous Junuba,[3] who are also Ghafiriya, they are blood enemies of the Wahiba though at present there is a truce between them. The Wahiba, who are probably rather less numerous than the Duru', are allied to the smaller tribe of the Harasis, both tribes being accounted Hanawiya. The Duru' own large herds of very good camels, many of which are sold at the two annual 'Id fairs at 'Ibri. A good riding camel [4] fetches 150 Maria Theresa dollars whereas in Dhufar it would sell for 300 to 400 Maria Theresa dollars. Both the Duru' and the Wahiba make rugs, decorated woollen saddle-bags,[5] girths and head-ropes, the Wahiba work being of the better quality. These and the black sheepskin saddle-covers from here are much sought after throughout southern Arabia. The Duru' trade salt from the deposits in Umm al Milh and from the mines at Qarat al Kibrit and Qarat al Milh, their caravans coming and going continually.

[1] The Imam, Muhammad bin 'Abdullah, lives at Nazwa on the western slopes of the Oman mountains. It is the largest town in Oman. He has Walis at 'Ibri, Izki, Bahla, Manakh, Samail, Rustaq, Nakhal, Bani bu Hasan, and Badi'a.

[2] The Duru', Junuba, and Wahiba supplement their diet of milk with dates and wheat flour. I found the Duru' extremely hospitable and the Wahiba have a similar reputation.

[3] The Junuba live both along the coast of the Arabian Sea to the east of the Jabal Sughra and among the foothills of the Oman mountains round 'Izz. There are some 'Awamir villages near Nazwa.

[4] The best Oman riding camels, renowned throughout Arabia, are from the Batina. The Wahiba also own excellent camels and send some of them each year for sale to Riyadh and Hufuf.

[5] These saddle-bags are made in one piece and are shallow, for use with the small Omani saddle on which the rider sits or kneels behind the camel's hump. The elaborate tasselled camel trappings of the north are unknown here. The Omani saddle is used by the Badu as far west as the Manahil. The Murra use the double-poled riding saddle common to the rest of Arabia.

Umm al Milh, where the wadis al 'Ain and al Aswad end, is an extension northwards of the considerable depression in which lie the quicksands of Umm al Samin,[1] the sump into which the wadi al 'Ain pours its floods from the Oman mountains. Separated from the sands of Al Ghafa by some 15 miles of gravel flats, the quicksands are indistinguishable from the surrounding plain, and many Arabs, including one large band of 'Awamir raiders, have perished in their treacherous depths. The Duru', who alone possess sufficient knowledge wittingly to approach their edge, describe an island, like a lofty castle and gleaming white, lying in the heart of the quicksands.[2] They believe it to be a storehouse of untold wealth whose approach is a lost secret.

The Rawashid returned after seven days, bringing wheat flour and seven packages of excellent 'Ibri dates. They had followed the wadi al 'Ain, past the two lava fields of al Hamma and al Harra, to the village of Tanam, and had then travelled up the tributary wadi al Kabir to 'Ibri. The towering, precipitous-sided Jabal Kaur, second in size among the Oman mountains only to Jabal al Akhdhar, 10,000 feet in height, rises to the south-east of 'Ibri. It was visible at dawn from Khaur Kadri, though it was later obscured by the haze which persisted while we were in these parts. This mountain is inhabited by the Bait Hanah. Hamad and Mubarak left us here, while 'Ali accompanied us to the great wadi of the 'Amairi. We travelled for three days over the featureless steppes, crossing the smaller Al Aswad, and arrived at the 'Amairi on the 14th. This is the largest of the wadis rising on the western slopes of the Oman mountains and has numerous wells throughout its course, unlike al 'Ain where there is no water below Khaur Kadri, and al Aswad with only Dhu Julaili and Duwaid in its upper reaches. Ghaf trees, samr and hardha acacias, and tarfa tamarisk[3] grow in their broad shallow courses.

At the 'Amairi we were joined by an 'Afari, Rai by name, who came with us to the Ghaba. These 'Afar, numbering some forty grown men, are Hanawiya but live among the Duru' and can make travellers free of both Duru' and Wahiba territory. They travel widely and are knowledgeable about the

[1] In general the Badu refer to the quicksands on the Trucial coast, south-east of the Qatar peninsula, as Sabkhat Matti and those on the Oman steppes as Umm al Samin. Some of the Rawashid however call Umm al Samin Sabkhat Matti and the ones on the Trucial coast Sabkhat al Jazira. These, unlike Umm al Samin, are not dangerous although a camel can become badly bogged in them.

[2] Cf. similar story about Nuqrat al Hadhaudha in wadi Sirhan recorded by Philby (*Geogr. J.* 62 (1923) 250).

[3] The vegetation of the Oman steppes is ghaf (*Prosopis spicigera*), samr (*Acacia spirocarpa*), hardha and salam (*Acacia flava*), tarfa (*Tamarix*), saf (*Nannorhops arabica*), raqa (*Salvadora persica*), abal (*Calligonium comosum*), markh (*Periploca aphylla*), sidr, 'arrad (*Salsola cyclophylla*), silli (*Cornulaca monacantha*), harm (*Zygophyllum album*), haqabit, hardan (*Suaeda*), rimth (*Haloxylon salicornicum*), haradh, niqawa (*Anabasis setifera* and *Statice Stocksii*), qasb, rimram (*Heliotropium persicum*), luwaila (*Iphiona subulata*), hulaira (*Tephrosia Apollinea*), qasis (*Cyperus conglomeratus*), zaut, la', luqam, maluh, zahra (*Tribulus macropterus* and *T. megistopterus*), hawai, birkan (*Limum indicum*), qarm (*Monsonia nivea*), sa'dan (*Neurada procumbens*), dimdim (*Indigofera semitrijuga*), qatab (zahrat al sih), dhaf (*Cleome brachycarpa*), hathma (*Convolvulus* sp.), ghuraira, naqi'a, harmal (*Salsola* sp.), hawai, umm qishqisha, shakir (*Gaillonia Aucheri*), khashfa (*Heliotropium* sp.), shibarqa (*Indigofera intricata*), darma (*Fagonia parviflora* and *F. socotrana*), niza' (*Crotalaria aegyptiaca*), sanna (*Cassia holisericea*), jithjath.

country. The Balhaf, who are Mashaïkh and of whom some thirty live here, are also generally accepted by both these tribes as "rabi'a." [1]

Beyond the 'Amairi we were on the Hadba, an extensive gravel plain extending south-east to the Hiqaf cliffs and north-east to the wadi Halfain. From the Raba' Jabal Kaur, the mighty range of Jabal al Akhdhar and towering Jabal Salakh were all clearly visible at sunset. We passed the prominent hill of Qarat al Kibrit, marking a depression 300 yards across and 15 feet deep where the Duru' and 'Afar dig rock salt in shafts varying in depth from 10 to 20 feet. They fetch it in big caravans for it is of better quality than the salt from the deposits of Umm al Milh. From the hillside they also dig sulphur which the Wahiba are allowed to carry away in times of truce as a cure for mange among camels. Twenty miles to the north-east is Qarat al Milh where more rock salt is quarried. This mine was given to Sultan bin Matar of the Duru' by Faisal bin Turki and is still the personal property of the Duru' Shaikh, only to be worked with his permission.

Near here we saw two gazelles, which are scarce on these plains, and later passed the stale tracks of an oryx, a rare visitor from the herds in the Jaddat al Harasis. Wolves, foxes, caracal lynxes, and ratels are all found here and an occasional hyaena comes up from the south-west, although the Arabs say there are no hyaenas or baboons [2] in the Oman mountains. Ibex (wa'l) are common there but I heard of no thar. Wild asses [3] known as "fuari" (s. farra) exist in the hills round 'Ibri and in the Wahiba country, especially round 'Ain Na'ama in the upper wadi Halfain, and are eaten by both the Wahiba and the Junuba. Ostriches have been extinct on the Oman steppes for about 40 years.

We crossed the wadi Musallim on January 20 and two days later arrived at the Ghaba. Larger than the Aswad and very well wooded with ghaf, it runs under the wall of the Hiqaf which extends south to the sea past Raqi and Baï. Rising in the lofty Salakh mountain, the Ghaba flows south to lose itself 250 feet above sea-level in the dreary saline depression [4] south of Hashi. South of this depression the ground rises again, Baï being 550 feet high. In the Ghaba were a few Junuba, Wahiba, and Harasis herding camels and a Luhaifi (pl. Balihaf) [5] collecting saf fronds [6] for sale on the coast. The Luhaifi agreed to

[1] Among these southern Badu a tribesman who gives protection to a party travelling among his tribe is known as Rabi'a. In the north he is more commonly called Rafiq or Khawi. He takes the following oath: انتم بربيعتى شلتكم فى وجهى دم وفارت

[2] Baboons are common in the coastal range to the west of the wadi Masila. I do not think that they are to be found in the Mahra country and there are certainly none in Jabals Qamr, Qarra, or Samhan. It is curious that they should not extend throughout the coastal range of southern Arabia.

[3] No specimens of this ass have been collected and in consequence it has never been described scientifically, but I think that it is probably an indigenous wild ass rather than the wild offspring of domesticated races.

[4] In the Hiqaf depression there were oyster beds composed of the species *Ostrea latimarginata* Vredenburg, usually regarded as a characteristic fossil of the lower Miocene.

[5] Most of the Balihaf live in the upper reaches of the wadi Hat to the west of Dhufar and are guardians of the tomb of Al Jauhari in the Mahra country. A few 'Afar live round Habarut.

[6] This dwarf palm (*Nannorhops arabica*) is found westward at least as far as the tributaries of the Masila. (Nashr palm?, see D. van der Meulen, 'Aden to the Hadhramaut,' p. 245, London, 1947.) It is used by the Badu to make ropes.

accompany us to Baï. We stopped for two days near Hashi well to slaughter a camel which we had bought for meat,[1] and to graze our tired mounts on the ghaf trees and abal bushes growing among the dunes. In places the limestone was exposed through the sand, which had drifted against rocky eminences to build up dunes 150 feet high,[2] rising from the sterile salt flats where there were a few small patches of arad but no other vegetation. Then for two days we struggled across the sabkhas, breaking through the surface crust at every step and floundering in the soft damp undersand. The infrequent ridges were chiefly composed of limestone, but here for the first time we found outcrops of red granite and of gabbro, and many fragments of porphyry, jasper, and rhyolite.[3]

We reached Baï on January 31 where old Tamtaim gave us an emotional welcome. He had been furious at my desertion by Sultan and the others and had vowed that he himself would set forth to seek news of us if we did not arrive after two and a half months. We remained at Baï until February 4 in order to collect the rest of the party who had scattered widely to graze their camels. A recent thunderstorm had fortunately filled some rock pools, for the water at Baï and Raqi is especially brackish. We then travelled across the featureless gravel plain of the Jaddat al Harasis which extends in unbroken monotony north as far as the sands. Here gazelles abound among the flat-topped acacias, trees which camels are unable to graze effectively and which the Arabs beat with their poles so that the small leaves and pods fall on to mats placed below. This they later feed as forage to the camels. We reached the adjacent wells of Ghanat and Khaur Wir on the coast after four days. Probably nowhere is there water more foul tasting and yet deemed drinkable but it was all we had until we reached Yisub six days later. Here in a narrow chasm was a long deep pool of clear water, shut in by polished limestone cliffs 150 feet high and in places barely 4 feet apart, where maidenhair fern grew in cracks on the damp walls. Nearby was the similar pool of Nahabub. Three days later we reached Andhur where Musallim, who had gone off hunting the

[1] Camel meat, sun dried and eaten raw, is sustaining.

[2] I am convinced that the giant dune masses of the eastern sands, although somewhat similar in shape, are not formed in this manner.

[3] P. M. Game writes: "The rocks collected by Mr. Thesiger from western Oman are noteworthy for the proportion and variety of igneous types. The seven distinct kinds represented include deep-seated varieties—granites and gabbros—and others of volcanic origin—rhyolites and tuffs. The collection also includes two metamorphic rocks, a black nephrite from the wadi al 'Ain and a feldspar-diopside rock (probably an altered limestone) from wadi 'Amairi and from the southern edge of al Hiqaf about 200 miles to the south. Sedimentary rocks are represented by limestones and sandstones of various colours.

"There is a fairly close similarity between some of the igenous rocks collected by Mr. Thesiger from the Oman mountain range, particularly the red tuffs and the black and green rhyolites, and the pebbles brought back by Mr. Bertram Thomas and Major Cheesman from the gravels of the Rub' al Khali and Jafura deserts several hundred miles to the west. It is impossible to be certain that Oman was the source of these pebbles since rocks of similar type occur in central west Arabia. It is probable that the materials of these great gravel plains have been derived from both eastern and western sources.

"Mr. Thesiger's collection together with a list and descriptions of the specimens are available for inspection in the Department of Mineralogy at the Natural History Museum."

day before, joined us after dark with an oryx,[1] the second he had shot since leaving Yisub. We reached Salala on February 23 after descending from Jabal Qarra by the wadi Darbat to Taqa.

The Sultan, Sa'id bin Taimur, had recently arrived in Salala and the town was full of Qarra, Bait Kathir, and Rawashid tribesmen who turned out in force to welcome us amid volleys of rifle fire. Many were the friends whom I saw again, but the best was Muhsin whom we had left at Mughshin so smashed up that it had seemed certain he would die. The indomitable old man had arrived, tied on to his camel, a few days before us. Salih bin Kalut, who had crossed the Empty Quarter with Bertram Thomas in 1930, was in Salala and the Sultan arranged for him to accompany me to Mukalla. I planned to travel there through the northern Mahra country, in order to fix the watershed between the wadis flowing to the sea and those flowing north to the sands, whose middle courses I had established the previous year, and I hoped to outline the general topography of the Mahra country, as yet unknown.

I engaged fifteen Rawashid but agreed that thirty of them should come with us, dividing their pay amongst themselves. They were unwilling to travel in a smaller party since their relations with the Mahra were far from cordial and they also feared the Dahm who were even then harrying the western steppes. Many of these Rawashid had been with me the year before on my journey to the Hadhramaut. Muhammad al 'Auf and Salim bin Kabina remained with me, and Bin Kabina was now accompanied by his friend Salim bin Ghubaisha, already a hunter of renown although only seventeen years old. Mabkhut bin Arba'in and four of his Bait Gidad came on with us, but unfortunately Musallim bin Tafl could not travel in Mahra country because he had killed two of that tribe in a blood feud. He left us after the first day's march and I was sad to see him go, remembering how he had stood by me when his tribe turned back in the sands of Ghafa.

Leaving Salala on March 3 and travelling by Kismim and Mudhail,[2] we arrived on the 15th at Habarut, where the Bait Zabnat were watering big herds of camels at the shallow wells. Here Musallim bin al Kamam and 'Abdullah bin Misad parted from us, for they were going as envoys to the Dahm to demand the return of 100 camels lifted from Sanau in January by a raiding party 200 strong. This raid had violated a truce concluded with the Dahm in 1946 by Bin al Kamam on behalf of the Kathir tribes, and had been followed by further raiding.

We now passed close to the wells in the Shalhamit, dry after a year's drought, and crossing the head of the Hat climbed on to the Daru plateau, a featureless gravel plain from which the run-off is to Sarif at the head of the Kidyat. Scattered over this plain were some rude shelters, walled with rocks

[1] Oryx are plentiful on the bare plains of the Jaddat al Harasis and on the sih to the west. I have not found them on the sands, though Philby encountered them there during his journey in the Rub' al Khali and the Yam hunt them in the sands to the east of Najran. Their meat is excellent and their hide makes good ropes and camel hobbles. The best water-skins are made from ibex skins and are worth about 10 Maria Theresa dollars.

[2] In my article "A new journey in southern Arabia," *Geogr. J.* 108 (1946) 132, I referred to this place as Mdhul. I find it is more commonly called Mudhail (pronounced Mulai).

and roofed with branches overlaid with earth and supported on pillars of piled stones, but empty now that seven rainless years had driven the Bait Khawar down into the Kidyat. A semi-sedentary Kathiri tribe,[1] these Arabs acknowledge the Sultan of Muscat and live on the Daru and in the deep, sheer-sided gorge of the Kidyat which begins abruptly at Sarif. Here a small spring trickles out among great slabs of fallen limestone from under the 200-foot-high precipice. I was watching some Mahra watering their herds at the palm-shaded water below us when a force of Bait Khawar collected and unexpectedly refused us passage. Our camels were already being led down the cliffs and a scuffle had begun around them before our rabi'a arrived and drove his tribesmen back. While we watered our camels they vowed that we should not travel down their valley unless we gave them money, and we maintained equally emphatically that having with us a rabi'a from their tribe we had the right of passage. Next day a large, voluble, but badly armed crowd had collected to bar our way. Our rabi'a offered to take us down the valley under his protection and despite their protests, but my Shaikhs were apprehensive lest we should be opposed and someone killed, thereby starting a blood feud between their tribes. I personally was indifferent as to which route we used and my companions, although they had previously been averse to travelling along the cliffs owing to the lack of grazing, now decided to travel by this road. This really suited my purpose best since from the high ground I could overlook the Kidyat, establish in it the position of the six palm groves of the Khaisa, and at the same time view the country to the south. We descended again into the valley at the small palm grove and shady spring of Umm Qarqar.

From Sarif the Kidyat flows west until it is joined below Umm Qarqar by the Mahrat from the west-north-west. Below their junction the wadi, now known as the Jiza, swings south to Murait and from there turns east to the sea at Ghaidhat al Mahra. The Jiza thus bends in a great arc, draining the larger part of the Mahra country. The Kidyat rises opposite the north-flowing Shuwait, the Mahrat opposite the Ramah, while the Lahan, its tributaries, and the Shawamit drain the mountains east of the Masila. The Jiza provides an easy and well-watered route through very broken country for caravans travelling from the free port of Ghaidha to the Hadhramaut or north and north-east to the steppes. Some frankincense [2] grows on the cliffs above the Kidyat and its gum is sent with goats and camels to the coast to be traded for grain and sardines. There are palm groves and small settlements with a little cultivation at Al Khaisa,[3] at Munair in the lower Mahrat, and at Dibin, Rabab, Bahat, Murait, and Dahal in the Jiza. In Munair [4] the palms, whose dates are said to be excellent, grow for six miles along the valley bottom in untended, nearly impenetrable thickets. At Dibin well-spaced, lofty palms,

[1] The Bait Khawar are divided into Bait Shahar at the head of the wadi Kidiut and Bait al Bahar in the lower half of the wadi.

[2] Most of the frankincense of southern Arabia grows on the Najd in Dhufar and provides a valuable cash crop to the Bait Kathir and some of the Mahra. It is exported to India.

[3] There are perhaps a thousand palms in the Khaisa, many of which are suffering from the continued drought.

[4] There is a fair-sized slave community in Munair who tend the cultivations.

most of them dead, are scattered over a large area but at Murait there are said to be large and flourishing groves. Munair, Dibin, and Rabab belong to the two small, semi-sedentary Kathir tribes of Bin Sandal and Bin Duwais, both akin to the Bait Imani. North of them are the Mahra of the Harawiz and 'Amarjad, to the west the Bait Gumsait and Bait Ushail, and to the south and south-east the Bait Kulshat and Bait Kuda.

We visited Dibin, intending to travel from there to the Masila, but the Bait Gumsait proved hostile and so we used Sulaim, our 'Amarjad rabi'a, to frank us through the tribes along the upper Mahrat. When travelling among the Mahra, as among the Qarra, it is best to be accompanied by a tribesman from each section along the route since a Mahri can usually only make his companions free of the territory of his own clan.[1] I have heard however that some of these clans will accept a Somali as a rabi'a, claiming that they are of common stock. Compared with their neighbours, the Mahra are rich in camels and goats. They speak a language of their own[2] but most of them can talk some Arabic, just as the Kathir can usually understand Mahra. They are reputed to be skilled in spells, and the many incantations chanted over the sick by the southern Arabs are always in the Mahra language. Once I watched them exorcise an evil spirit (zar) from a demented boy, a curiously biblical scene in the moonlight.[3]

We camped in the groves of Munair, guarded at each end by a fort and dominated by the ruins of another and much older fort on the cliffs above, and then travelled up the Mahrat to the head of the Ramah and through some very broken country down the Waqtat to Dahal well. Ibex were very common among these precipitous gorges and we saw many small flocks silhouetted on the cliff tops. Salim bin Ghubaisha and Suhail bin al Kuwait, a Bait Gidad boy, hunted them with tireless energy and generally with success. Skilled hunters are surprisingly few among the Badu, yet these lads brought us in gazelle or ibex almost daily so that we fared well.[4] There were a few Manahil at Dahal and they told us how two small children left with a load of sardines at the well had recently been killed and eaten by a wolf during the night. Since crossing the watershed we had been in the territory of the Manahil, allies of the Rawashid and Bait Kathir. They have however been mercilessly harried in recent years by the Dahm who have lifted a large part of their herds. At Dahal we heard that a powerful force of these raiders had been seen near the wadi Jinab, and the available information indicated that they would strike past this well at the herds which had escaped into the broken country south of Jabal Fart. Fearing this, the Manahil had evacuated the

[1] For sections of the Mahra see *Geogr. J.* 108 (1946) 141.

[2] Mahra is a Semitic language. See essay on "Mahra" in 'The encyclopaedia of Islām,' vol. 3, 1, pp. 138–44, Leiden and London, 1936.

[3] For aches and pains, especially in the chest and stomach, these Badu cauterize. For fever or fits (which are generally cataleptic, I think) they chant incantations over the sick and scatter offerings of food around to appease the local spirits. Many places, especially in the tributaries of the Masila, are "hauta," sanctuaries where no tree may be cut or grass plucked. To-day they are often associated with the tombs of Muslim saints but I am convinced that their sanctity goes back to pre-Islamic times. Perhaps there were sacred groves in these places.

[4] Even the rams are good eating.

Wahsha valley. The country between us and the Masila was consequently empty so that we now moved with care.

We reached the Masila on April 10. Early next morning a Manhali rode down the wadi rousing the Arabs to arms [1] for the Dahm were reported in the vicinity of Saum. We moved up to Faughama, past the famous shrine of Nabi Hud,[2] and camped in a side wadi. After dark there was another alarm and shots in the main wadi so that we saddled our camels and extinguished our fires. 'Aidha bin Tanas, the Manahil Shaikh, arrived next morning with some thirty of his tribe. He asked us to join him in a pursuit, which we agreed to do provided that he mounted us and that we were satisfied that his information was reliable. From the conflicting reports it seemed probable that the Dahm had surprised an 'Awamir encampment near the head of the Wahsha three days before, killing eight of them. We remained here for three days and then, hearing no more of the Dahm, travelled to Ghail ba Yamin in Humum territory and from there over the Jaul and down the wadi 'Arf to the coast. We arrived at Mukalla on May 1.

I had come amongst these Badu as a Christian and a stranger to share a communal life where privacy was unknown, where every word was public and every action seen. Crowded together in the immensity of the desert, we had lived subject to the rigid discipline of their ways. Now I had reached the end of my 2000-mile journey. For six months and more I had travelled with them, and between us was the bond of hardships endured together and the comradeship of desert life. The Mukalla townsmen scorned them as wild Badu from the Rub' al Khali, that half mythical land of emptiness and death, while they in turn viewed these glib fat merchants and their crowded sea port with arrogant disdain. In a day or two they would be gone, Muhammad, Mabkhut, and Bin Kabina, Salih bin Kalut, 'Awad, Bin Ghubaisha and young Musallim bin Nauf, returning across the mountains to the desert and the harsh freedom of nomad life. The biting cold of the winter nights, the blinding heat of summer, hunger verging always on starvation, thirst, drought, and the danger of sudden raids, such were the hardships and hazards of their existence and the secret of their character. Often I had been exasperated by their avarice and wearied by their endless discussions, but I had witnessed their courage and self-reliance, their endurance and their pride of race, and I remembered their patience, generosity, and unselfishness. I know that they and their way of life are an anachronism and will tend to disappear, but I also know that amongst them in the desert I have found a freedom of the spirit which may not survive their passing.

Mr. Philby very kindly checked and corrected the transliteration of Arabic names in this paper and on the map. I am extremely grateful to him for

[1] The Bait Kathir name famous camels in their battle cries. Thus the Bait Gidad use Rai Safra (herdsman of the yellow camel), the Shalahma use Rai 'Arqa, and so on; and constantly in an argument they shout them out to express angry disagreement. The battle cries of the Rawashid are Hamdan ya ibn Yaddi (Jaddi) or Ba Rashud, but individuals name their sister or favourite camel. The Mahra use Ya Dakai.

[2] Nabi Hud, not Qabr Hud as marked on existing maps, is the name of this shrine which is often called Nabi for short. I was told that Hud was not buried here.

undertaking this laborious task which he alone possesses the requisite knowledge to perform.

I also wish to acknowledge the assistance of R.A.F., Aden Command, in providing stores, transport to Salala, and accommodation and much help while in Salala.

Note on the maps by K. C. Jordan

Both maps are based on Mr. Thesiger's compass traverses plotted at his estimated speed of travel.' The first part of the route to the Rub' al Khali, from Salala as far as Ma Shadid, coincided with that of his previous journey and no bearings were taken. The position of Ma Shadid was thus accepted from his earlier map and the traverse up the wadi Ghudan was fixed on the established position of Shisur with little adjustment. From Shisur to Matki and Al 'Ain the new traverse corrects the position of Marsaudid and Al Barsa', the established position of Matki being accepted. North from here through the Rub' al Khali no previously mapped feature was encountered until the wadi al 'Ain was reached and the first intersections on Jabal Kaur were made, suggesting that the rate of travel through the sand area was slightly overestimated. The traverse was adjusted in accordance with the established position of Jabal Kaur and to the south it was tied almost without adjustment on Table Mountain (Mazka Kabir) of Bertram Thomas, Khaur Wir on the coast, and Andhur well of the previous journey.

From Salala to Mukala the former route was followed as far as Habarut wells, the position of which was accepted. From here the traverse runs through unmapped country to Ingrams' position for Qabr Nabi Hud in the wadi Masila, and then south to the wadi above Shihr.

DISCUSSION

Before the paper the PRESIDENT (The Rt. Hon. LORD RENNELL OF RODD) said: This evening, the first meeting of the session, we are to have a paper by Mr. Wilfred Thesiger in which he will give an account of his second journey into the Empty Quarter of Arabia, one of the last great land areas almost unknown to us, but not of course unknown to those who live there and to those who are represented to-night by the Saudi Arabian Chargé d'Affaires, whom we are particularly glad to welcome in this Society. He represents one who for twenty-five years has believed in us, who has stood by us without any alliance and without any reason except that he believes, as we believe, in the standards of life that ought to govern people. It is therefore particularly appropriate that H. E. King Ibn Saud's representative should be here to listen to Mr. Wilfred Thesiger.

Mr. Thesiger's second journey, as his first, was made possible by the Anti-Locust Research Centre, an international organization centred in London. Although some of what Mr. Thesiger will have to say is not new to those who read the Society's *Journal*, it is a long time since we have had the pleasure of welcoming him in person to speak of the many journeys for which he is too little known.

Mr. Wilfred Thesiger then read the paper printed above, and a discussion followed.

THE SAUDI ARABIAN CHARGÉ D'AFFAIRES (Sayed Jamil Dawoud el Mussallamy) spoke of his appreciation of Mr. Thesiger's paper and of his pleasure at being with the Society.

Dr. B. P. UVAROV (Director, Anti-Locust Research Centre): The journey which Mr. Wilfred Thesiger has so well described was only part of a very large programme designed to bring about the control of the desert locust and to discover its main habitats. In 1942, when the military situation in the Middle East was not too favourable, there loomed on the horizon another enemy—the desert locust. We knew sufficient about this insect to realize that if allowed to breed unchecked it might constitute a most serious menace to the economic stability of the Middle East and various parts of Africa which were exceedingly important both economically and politically. Therefore it was decided to organize a large-scale motorized campaign in an attempt to control the desert locust. With the aid of the military forces and with the backing of the State it was possible to plan an investigation on the large scale necessary; and it was possible to accomplish what we set out to do because of the friendly and ready cooperation of other nations, especially Saudi Arabia. H.M. King Ibn Saud himself understood well that in this battle with the locusts a great deal of work had to be done in his country, and we were not only welcomed there but helped at every turn. Obviously there were many corners that could not be reached, and we had to find somebody who would go into those corners. In Mr. Wilfred Thesiger we found such a person. In spite of all the difficulties, which Mr. Wilfred Thesiger very greatly understated in his paper, we have obtained as a result of his investigation a fairly good knowledge of which areas are dangerous and which are not. I am very glad to hear that in addition he found time to investigate many other problems and to bring back other data which have increased very materially our knowledge of this part of Arabia.

Brigadier R. A. BAGNOLD: I was most interested in Mr. Thesiger's photographs of the sands of the Rub' al Khali. They are the first photographs which show in any kind of detail what the shape of the sands is really like. It has been interesting to me this evening to be able to compare the appearance of the dunes in the Rub' al Khali with those with which I have been familiar in the Libyan desert. In the map of Arabia with the sand depicted in yellow you saw a great sweep of sand dunes coming down from the north; there were two vast lines of two chains of sand dunes, starting off from the north in a south-south-easterly direction, then turning due south, and then sharp to the south-west. There is exactly the same great sweep of dunes on the other side of the Nile, away in Libya.

Since the orientation of a dune chain in any part of the world is a function of the strength and direction of the wind which moves the sand and of little else, and since the orderly growth and marshalling of dune chains on this grand geographical scale must have been exceedingly slow, it is clear that we have here a record of the wind regime running back perhaps 50,000 years into the past. The interpretation of this record is not yet possible. It will need the collection of more data on the rate of growth and movement of the dunes.

The shapes of the dunes of which we saw pictures reminded me very much of the shapes of the dunes along the southern end of the Sand Sea which separates Egypt from Libya. There the northern sands appear to have crept southwards along the great curved sand route, driven by the prevailing wind, till the advancing dune chains have entered an area where strong winds blow from the opposite direction for a period of the year. The advance of the dunes begins to be checked and is ultimately halted, and the sand is banked up into complex forms of folds and pockets such as we saw in the slides to-night.

It was mentioned by the lecturer that when rain fell on the dunes, any vegetation that happened to be there remained alive for some years afterwards. In my experience that depends on how the various layers of sand in the surface have been deposited. If the dune has been creeping on by successive avalanches

of sand down the steep lee slope, the internal structure of the dune is stratified at an angle of about 33°. When the rain falls on such a dune, it tends to seep downwards along the strata and can penetrate a foot or more below the surface, where it remains for long periods without evaporating. Where however sand is deposited evenly on a smooth streamlined sand surface, the dune is built up in strata which lie parallel to the surface so that when rain falls it spreads over the surface and does not sink. Thus it evaporates immediately afterwards. You do not get vegetation on that type of dune structure, though you do get it on the type which has been built up by avalanching. The former sand structures are always firm underfoot, and the latter are soft.

I would, in conclusion, like to ask Mr. Thesiger exactly what he meant by the quicksands he mentioned towards the end of his lecture. Were they actually dry desert quicksands or were they the usual quicksands where sand is partially under water? If they are the dry type of quicksand and remain so in spite of the fact that people have walked over them and flattened them down, the answer must be that gas is coming up from underneath and is loosening the grains and keeping them disturbed, just as wet quicksands are due to upflow of water from underneath.

Mr. WILFRED THESIGER: The quicksands to which I referred are the Umm al Samin which are not dry but wet quicksands. In a sense, they are not in the sands at all; they are on the steppes against the edge of the sand at the end of the wadi al 'Ain, the biggest of the wadis which come down from the Oman mountains. I am told that the quicksands cover an area of 400 square miles and that they are indistinguishable from the gravels or salt-pans all round them. You never know when you are in the quicksands until the sand starts breaking up behind you. From talking to Arabs who have seen sheep engulfed in them I have no doubt that they are liquid. There has long been a tale from the other side of Arabia of a place in the western sands known as Bahr al Safi, and there the quicksands are dry and powdery. I have never heard that name used by the Arabs but it is mentioned in a number of books. We need a good deal more confirmation of that before we accept it as true. The only sands I know to be dangerous are those of Umm al Samin. In the coastal areas there are other quicksands which are not dangerous.

The PRESIDENT: We have heard the story of what is perhaps the hardest piece of travelling that any member of this Society has undertaken up to date, at any rate in that part of the world. The standard of life of the people among whom Mr. Thesiger lived is hard. That he should have shared that, and indeed have persuaded them to endure an even harder life, is a tribute to Mr. Thesiger's endurance and perseverance. Above all however his life there is a measure of the love that he bears to the people among whom he has travelled, without which he never would have been able to do what he has done. I ask you to join with me in thanking Mr. Thesiger and wishing him very good fortune on his next journey.

AUSTRALIA'S FRONTIER PROVINCE

THE HON. C. L. A. ABBOTT

Administrator of the Northern Territory of Australia, 1937–46

Evening Meeting of the Society, 31 March 1947

THE NORTHERN TERRITORY, one-sixth of the Australian mainland, was little known, even in Australia, before war came to the Pacific. Its capital, Darwin, was heavily bombed by the Japanese in February 1942, when there was very considerable loss of life, many ships were sunk, and much damage was caused to the town, which then had a population of 6000.

The Territory is a land which has presented many complex problems. Some of these have been common to the rest of Australia, but others have been peculiar to the Territory alone. The main common problems have been aridity—areas with a low rainfall—and, conversely, areas with a high tropical rainfall falling only in a certain period of the year. Before speaking of the measures that should be taken to develop the Territory, I will describe briefly the geographical setting.

There is a very general impression that the Northern Territory is a vast expanse of sandy waste and that little of it is fertile. This is by no means so. Like all the States of the Commonwealth, it has its various lands, but it has few stretches of country which are as poor as the desert country around Lake Eyre in the north of South Australia or the north-west desert of Western Australia. It has many thousand square miles of excellent grazing country and many areas of fertile land which are fit for agriculture. The land may be classified in fifths, each fifth representing 100,000 square miles. One-fifth is good pastoral land; one-fifth is second-class pastoral land capable of development; two-fifths must at present be classed as indifferent land, coastal and rocky, low-rainfall country without water; and one-fifth is desert. This is a fairly conservative estimate.

Rainfall over a very considerable part of the Territory is influenced by the annual monsoons which sweep south from India and Java and break over Darwin in the months of November to February. The fall is 60 inches over Darwin and decreases inland to the south at a rate of about 10 inches to every hundred miles. There are several large rivers, mostly in the northern area. The largest of these is the Victoria River which is nearly 1 mile wide where it meets the sea. Other rivers are the Roper and the Daly. These three rivers have an average length of about 300 miles; their valleys have tracts of agricultural land, and their flow can be called permanent. There are many other streams which are raging torrents in the wet season but which shrink greatly in the dry months. Inland most of the country retains little surface water, but sub-artesian water is obtainable in the eastern pastoral belt by boring to depths between 200 and 300 feet. In the western pastoral country the sub-artesian water is less certain but this area has a fairly high average rainfall and is well provided with surface water.

A very considerable amount of the Northern Territory has been taken up and occupied to some degree. The figures for 30 June 1943 are:

	Square miles
Occupied lands, including lands held by grazing licences, etc.	226,731
Aboriginal reserves	67,257
Other reserves	2,000
	295,988

That is to say, approximately 300,000 square miles out of a total of 523,000 square miles have been occupied. There are 100,000 square miles of first-class grazing country and at least 100,000 square miles of second-class grazing country which would respond to development and management. Over 50 per cent. of the Territory could be put to use and settled, which is in the same proportion and possibly a little better than some of the adjoining States which are in a much more advanced state of development.

Much of the unoccupied land is "spinifex" country. Spinifex is a prickly shrub, growing in clumps about 3 to 4 feet in height. At certain stages of growth it has a slight food value and cattle will eat it. As a rule the soil of the flat country where it is found is a sandy loam which responds very quickly to water and will grow vegetables and fruits including oranges. Good water is nearly always obtainable at a depth of 200 to 300 feet. One feature of spinifex is that it holds the soil and consequently there is little erosion.

Three-fifths of the Northern Territory are timbered, from the tropical forests and jungles of the north to the mulgas, desert oaks, and lancewoods of Central Australia. Nearly all the trees are hardwoods, but there are belts of cypress pine.

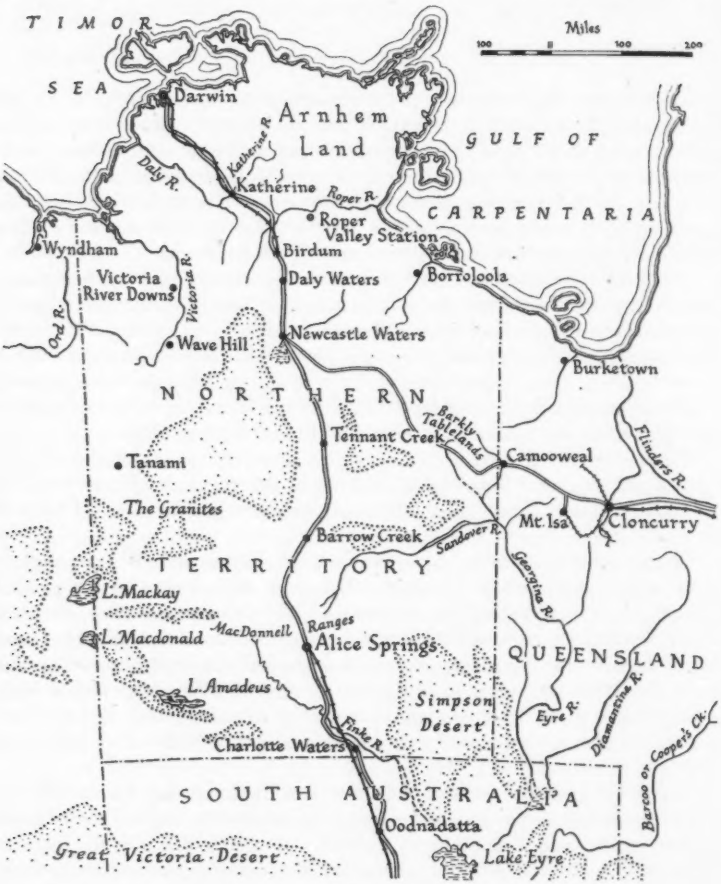
The pastoral lands lie to the east and west of Newcastle Waters, slightly north of the centre of the Territory. There are other pastoral lands around Alice Springs, 1000 miles south of Darwin. The country rises gradually from Darwin to Alice Springs, which is 1900 feet above sea-level and has a very good winter climate, the days being clear and sunny and the nights cold. There is proof that Alice Springs is good pastoral country in that cattle trucked from Alice Springs to Adelaide nearly always top the Adelaide sales, although they may travel 200 miles by road and 1000 miles by rail before they reach the market.

Among the industries of the Northern Territory, pearling was carried on from Darwin before the war, and the pearling beds were rich with very good quality pearl shell. The industry, which was worth £80,000 to £90,000 annually, was devastated by the war, many of the pearling vessels being sunk or badly damaged, and it will require a great deal of reconstruction and assistance, both in equipment and in divers, before it can again be a tangible asset to Australia.

Another industry was the export of buffalo hides. The buffaloes were first brought from Java during the early days of the British settlements, from 1825 onwards. Some escaped and the wild herds increased greatly. They are shot for their hides from horseback during what are called "runs." The men are armed with short-barrelled guns and as they must get very close to the beasts

the runs are not without risk and excitement. Buffalo hides weigh up to 40 pounds each and, before the war, sold for over 1s. a pound. The shooting of buffalo cows and calves is prohibited.

There is every sign that there will be a revival of the gold mining industry. The main mining centre is at Tennant Creek, 300 miles north of Alice Springs.



Since 1934 this field has produced over one million pounds' worth of gold and has averaged one ounce of gold to every ton of ore crushed. Recent prospecting has revealed a gold-bearing stratum which in one place yielded over sixty ounces to the ton, and the entire prospect averaged ten ounces. Another area, away to the west, has been prospected by diamond drilling and shows very good results. It is probable that this will become a large-scale company operation.

But the great asset of the Northern Territory and the way to maturity is the

pastoral industry. There are over 50,000 square miles of good pastoral land to the north-west of Newcastle Waters, including the Wave Hill and the Victoria River districts, 40,000 square miles on the Barkly Tablelands to the east, and 30,000 square miles in the Alice Springs district. Besides these there are a further 64 million acres of second-class grazing land which can be brought into production. Here there are cattle stations which are principalities; for example, there is Victoria River Downs, 12,000 square miles with 150,000 head of cattle, owned by the British firm of Bovril, and there are other stations ranging from 2000 to 6000 square miles. As there are no railways, these stations have to walk their cattle across the Territory stock routes to the southern states and markets. Every year between April and October, 70,000 to 90,000 head of cattle walk at least 800 miles into Queensland. There they are rested and pastured for a year or are trucked on the Queensland railway system.

The progress and the development of the Northern Territory, such as it is, has been almost entirely due to the efforts of the pastoral lessees who, in spite of many difficulties of distance and transport, have increased their herds and improved their properties. They have done this without government assistance and, in some instances, against tacit government resistance. Their efforts have had a tangible result and the exports of the Northern Territory have shown some return for the money which has been spent in developing the country. The value of the exports of cattle, minerals, pearl shell, and buffalo hides since the 'nineties has been estimated at £15,000,000.

There has been no lack of advice as to how the Northern Territory should be developed. There have been Royal Commissions, Parliamentary committees of inquiry, investigations, and a succession of reports. In the main these reports have been sound and they have all advocated more or less the same action. They have urged the construction of railways, closer communications, and, above all, encouragement of the pastoral and cattle-rearing industry by a sympathetic policy of land administration. In 1937 a complete survey[1] of the pastoral industry was made by two nominees of the Federal Government, Messrs. W. L. Payne and J. W. Fletcher, who had a profound knowledge of the subject. Their report stated that if their recommendations for a policy of railway-construction and pastoral-development leases were adopted and carried out, the Northern Territory would double its cattle numbers and would carry millions of sheep, the white population would increase from 5000 to 50,000, and eventually wealth to the value of £4,000,000 per annum would be produced. Their recommendations were not adopted and a period of stagnation will inevitably settle on the Northern Territory unless action is taken. Successive Australian Governments have failed to realize that a policy of long leases is necessary so that lessees can embark upon programmes of long-term expenditure on improvements with the prospect of being recouped for such expenditure. If this is not done development cannot take place. In no other part of the British Empire is there such a vast tract of land which is so lagging in development and which would so respond to it.

The history of the recent war years, particularly from 1941 onwards,

[1] 'Report of the Board of Inquiry appointed to inquire into the land and land industries of the Northern Territory of Australia,' Canberra, 1937.

provides additional arguments for development. The Northern Territory was a vital link in Australia's defence and at one time the danger of invasion by the Japanese was very real. Their forces were massed only 400 miles away across the Timor Sea. After Darwin was bombed in 1942, Australian, American, and Dutch forces poured into northern Australia and 100,000 men were concentrated there. During those years the service personnel and men engaged upon war work were entirely supplied with meat from the Territory, and farm gardens were established where millions of pounds of tomatoes were grown as well as hundreds of tons of cabbages, cauliflowers, lettuces, and all kinds of tropical fruits such as bananas, pineapples, and paw-paws. The importance of these vegetable farms is that they extended in a chain from Darwin to Alice Springs, and it was found that wherever there was water the soil was capable of growing everything that was planted. This gives confidence for the future and a foundation for a scheme of closer settlement and agriculture.

The war years stopped all civil development but they gave the Northern Territory two very fine highways, one 970 miles long from Darwin to Alice Springs, and another 450 miles long to Mount Isa in Queensland. There is also a magnificent aerodrome at Darwin with a runway of 11,000 feet, capable of taking all types of aircraft.

In 1945 I furnished the Federal Government with a considered report [1] in which I dealt with the major problems of the Territory and the conclusions I had arrived at during my term as Administrator from 1937. In that report, which was presented to the Australian Parliament in February 1945, I set out the basic recommendations which would enable the Northern Territory to develop. Among the recommendations was the construction of a railway line branching off the Queensland railway system, from Mount Isa through Camooweal and the Barkly Tableland to Newcastle Waters. The railway line running south from Darwin which terminates at present in a swamp at Birdum, 317 miles away, should be extended, first to Daly Waters and then to Newcastle Waters. This would link Darwin and the north with the Queensland railways and with Brisbane and Sydney. Agreement should also be reached with South Australia to construct a railway northward from Alice Springs to Newcastle Waters and so bring Adelaide into the railway link. The total railway construction would probably be between 1000 and 1200 miles, but without adequate railway communication it is not possible to develop the Northern Territory. Roads can never meet this need; only railways can.

In my report I then dealt with the subject of water conservation. It has always seemed to me that until an adequate and far-sighted policy of water conservation is adopted throughout Australia it is useless to think of immigration in terms of the millions which are essential to her safety and progress.

Conservation of water must be considered in relation to the northern portion of the Territory rather than to the southern. Central Australia has very little permanent surface water and no permanent running rivers. It has the Finke and the Sandover, which occasionally come down in roaring torrents and hold water in their sandy beds for some months afterwards, but these are not permanent. The pastoral lessees have established many waters on their runs

[1] 'Report on the administration of the Northern Territory for the year 1943–44,' Canberra, 1945.

Phots. by courtesy Australian News and Information Bureau, Australia House

Creek in spinifex country between Katherine and Victoria Rivers

In the grasslands of the coastal plains near Darwin

In the Macdonnell Ranges near Alice Springs

A tributary of the Victoria River

by boring and they are now realizing that it would be wise also to establish catchment dams where the fall of country warrants their construction. Although there is considerable evaporation in Central Australia, some authorities setting it as high as 97 inches annually, the position is no worse than it is in Queensland and South Australia, where pastoralists have many dams or earth tanks at which they have watered their stock, including sheep, for years. However it would not be wise to advocate any form of irrigation in Central Australia beyond station gardens and, in favoured spots close to Alice Springs, the establishment of market gardens.

Alice Springs itself has a remarkably good water supply, a fact which was confirmed beyond all doubt during the war. In 1937 part of the town of Alice Springs was supplied with water pumped from government wells 40 to 50 feet deep. The consumption of this water was watched very carefully and if it rose above 50,000 gallons a week warnings were issued. During the war Alice Springs had large military depôts where motor convoys began their 700-mile drive with supplies for the armies in the north. The consumption of water went up by leaps and bounds until it averaged 200,000 gallons a day, and on one memorable occasion rose to 600,000 gallons in 24 hours, without any appreciable effect upon the water levels in the wells. This means that the future of this pretty little Central Australian town is assured, at least so far as water, lawns, and gardens are concerned. As it has a beautiful winter climate it will doubtless attract many visitors who wish to escape the cold of the southern cities.

It is in the north, with its regular monsoon rains extending over a third of the Territory, that attention should be given to irrigation possibilities and I had this in mind when I made my report to the Government. Perhaps I can give you the salient points by quoting from the report (pp. 5–6):

"The future of this country (the Darwin and Gulf country) is largely bound up in the future of Darwin and the large demands for foodstuffs, etc. which may possibly be made by service personnel visiting or quartering there. Another factor which may also have a most important bearing is whether settlement is to be made available for some of the overcrowded peoples of the Old World. These are very definitely matters of high and even world policy. I will therefore only say this: that the opportunity for irrigation settlement is definitely in the Northern Territory. In the northern portion of the Northern Territory are three rivers, all running into the sea. These are all north of the 18th parallel and are the Victoria, the Daly and the Roper. They are each approximately 300 miles in length. The Victoria river has a catchment area of 29,000 square miles and its basin has an average rainfall of 25 inches per annum. The Daly river has a catchment of 29,000 square miles and 60 per cent. of the area has a rainfall of over 40 inches per annum and only 15 per cent. of the area has below 30 inches per annum. Its main tributary is the Katherine river.

"The Roper river has the largest catchment area, over 19,000,000 acres. This is larger than the State of Tasmania. Its basin has an average rainfall of over 25 inches. A great deal of this country is comprised of arable land and a lot of it would be easily accessible from the Gulf of Carpentaria."

Before writing this report I sent a Government engineer to the Roper River country to report on the waters there. I remember that his report opened with the words, "The situation at Red Lily, Wagon Lagoon and various other channels along Roper through the Roper Valley Station is a Water Conservation and Irrigation Engineer's dream." I recommended strongly to the Government that there should be an investigation of the Roper River valley with a view to irrigation settlement, the investigation to include soil analysis. I have referred to the Katherine River, a tributary of the Daly River. Not very far from the town of Katherine, this river flows through an immense gorge. Many skilled army engineers visited this gorge during the war and they all agreed that it would be feasible to erect a dam and establish a hydro-electric station there. It seemed to me that this could be linked up with the Roper River scheme, and I recommended that this proposal also should be investigated. Nothing however has been done.

I consider that settlement in this area is vital, as it is bound up with the all-important question of Australian and, indeed, Empire defence. Northern Australia escaped invasion in 1942 only by a hairbreadth. It is not easy to foresee the future but it is clear that an empty and unpeopled north will always be a very definite danger to Australia. The future of the British Empire depends upon planned development within its boundaries and such development must include the Northern Territory. It is of course clear that responsibility for the Territory rests entirely with the Australian Government, but the reallocation of population and the planning of migration within the Empire is a British responsibility as well as an Australian one. Moreover we should not plan for British migration only to Australia. The times are thoroughly out of joint in Europe and there are millions of potential emigrants. Indeed, many would be better suited to the tropical life of the north than British people. Here, if the rivers are harnessed, if water can be made to run through the land, are unlimited opportunities. The climate is healthy, the land can be made to yield, and there could be homes and security for many, at present, unhappy people. One good reason why the Territory has not been developed and why this has not become a pressing subject in Australia is that Australia has so much land and so few people. This position must be changed. Australia has stated that she will take a much more important part in defence of the Pacific than heretofore. The necessary expenditure cannot be carried by only seven million people; yet here to the north is this vast land capable of carrying so many more.

I am not alone in thinking that this country can support settlement upon a large scale. When I was Administrator of the Northern Territory I arranged for two distinguished observers to visit it. One was the then American Minister to Australia, Mr. Nelson Johnson, and the other was the High Commissioner for Canada, Mr. Justice Davis. They both went through the country in 1944 when the stock routes were open and cattle were passing through to Queensland. Both were equally eulogistic and in public speeches spoke of the possibilities of the north in glowing terms. Their view is supported by almost every Royal Commission report as well as by other investigators appointed by various Governments to advise on the policy by which the Territory could be developed. The responsibility and the blame for lack of

development does not rest specifically with the present Government. It goes farther back and must be attributed to the dwindling interest, first of Great Britain herself, then of South Australia, and last of the Australian Commonwealth Government.

Development of a country is a long process and can only be built up over the years. Australia is the youngest civilized country in the world. It is only 160 years since Governor Phillip established the first settlement in Sydney Cove where now stands a city with over one million people. It is eighty-four years since South Australia took control of the Territory and it is thirty-six years since the Commonwealth of Australia assumed responsibility. It is remarkable perhaps that the Territory has been able to attain its present state with so few friends and advocates, without full parliamentary representation, and, I am afraid, without permanent and patriotic citizens.

I wish I could take you to see these lands. First we would go to the pastoral country. From Newcastle Waters we would drive to the east and within 20 miles we would be on the Barkly Tableland. Vast grassy plains would stretch to the horizon, rolling away in hundreds of miles of waving Mitchell and Flinders grasses, the best natural feed. We would drive by car all that day and all the next and on the third day we would reach the Queensland border, but the rolling plains would still be with us.

Or we would go west from Newcastle Waters, first through light forest country, then through the lancewood scrubs where vast avenues half a mile wide and 6 to 10 miles in length have been cleared so that the passage of stock is less difficult. In a day and a half we would reach more rolling plains around Wave Hill and Victoria River Downs, timbered and grassed hills and shaded plains with rivers threading through them. But you would drive 180 miles to the east and 240 miles to the west before you came upon a station homestead. History shows that nations have fought and men have died for the possession of lands less fertile than these.

I once drove 400 miles north-west through Central Australia, over hundreds of miles of spinifex plains, to the goldfields of the Granites and Tanami. More than ten years ago there was an ill-fated gold rush to this place along a road now known as Tragedy Track, without water and without any sign of life, where, on the fringe of the pastoral country, a lonely marble column stands to the memory of the last white settler murdered by blacks, in 1928. Yet here, in this vast silence, a large mining company hopes to establish a mining town of at least 2000 people and to wrest over one million pounds' worth of gold from the earth. Roads will be made and motor lorries will roar through the night to the railhead at Alice Springs.

It was strangely beautiful to drive back from here to the east and see the marvellous MacDonnell Ranges rising in blue and purple hazes out of the distant plains. It was wonderful at evening to draw into one of the big Government bores where the 24-foot windmill was pumping 2000 gallons an hour of clear soft water. The cattle were drawing away across the grassed plains after their evening drink; thousands of parrots, cockatoos, and painted finches were wheeling and turning in the last of the sunlight, and there was a feeling of peace and contentment. All this made me feel that here was a land with a future, and that with friends and above all with a progressive plan of

development it could become another great state of the Australian Commonwealth.

And now, finally, how is this to be done? How is the Territory to increase its white population from one person to every 85 square miles to a population of thousands? How are the pastoral holdings to be reduced in size so that the average holding will not be more than 1000 square miles? How is agriculture to be revived and how is closer settlement to be established so that there may be thousands of small farmers along those great but lonely rivers of the north?

There is an answer to all this and a constructive one. It is not a new one just discovered but is to be found in many of the reports and recommendations made by experts advising on the future development of the Territory. The first need is extension and security of tenure for the pastoral lessees. This is stated concisely in the report by Payne and Fletcher already cited. Paragraph 109 states:

> "In the early days, when the future potentialities of lands were not clearly known, it was necessary to proceed with great caution; but later, when settlement prospects could more accurately be gauged, longer leases became possible. For instance, in Queensland 75 years ago the longest lease a pastoralist could obtain, even in the most remote districts, was for a term of 21 years. Now leases up to 40 years can be granted, and if extensive improvements and development conditions are undertaken, absolute security of tenure can be obtained by the elimination of all Crown resumption rights. Increasingly in recent years Governments are coming to realize that business terms must be granted if reasonable development is to be obtained."

And in paragraph 111 the recommendation is clear:

> "Pastoral Development Leases or leases in respect of which extensive development is undertaken should be granted for terms up to 50 years with appropriate conditions, so that the expenditure on development may be a business proposition to the lessees."

The next point is railway construction and once more the report (paragraph 155) states the case:

> "The portions of the Territory not served by railways which admit of the greatest land development, both in regard to cattle and sheep, are the Barkly Tableland abutting on Queensland, and the north-west country abutting on Western Australia. In neither of these localities would a railway be justified merely for the transport of cattle as such transport is not a paying proposition owing to the fact that it does not provide any substantial back loading. But the construction of railways to these districts would enable considerable areas to be utilized for sheep, and this entirely alters the outlook."

The position in Australia regarding developmental railways has become rather obscure owing to the recommendations for the standardization of railway gauges. However desirable this may be, the latest estimate of cost is £237,000,000, and with Australia's huge war debt and her very limited population it would almost seem that this is not practicable, particularly as certain states are opposed to parts of the scheme. A far better plan would be to continue the Queensland railway system into the Northern Territory. With

such communication, pastoral holdings could be subdivided and closer settlement undertaken.

The Old World and Great Britain herself are suffering from over-population, a serious problem in these days of world food shortages. But Australia is in a graver condition. She is suffering from under-population and the consequences of this may be very serious if the situation is not soon remedied.

DISCUSSION

Before the paper the PRESIDENT (The Rt. Hon. LORD RENNELL OF RODD) said: This evening we are privileged to have a paper by Mr. Abbott on the Northern Territory of Australia. Mr. Abbott was Administrator of the Northern Territory from 1937 throughout the war years, and he has served as Minister of Home Affairs in the Commonwealth Parliament. The Northern Territory and, indeed, the Continent of Australia have always been of considerable interest to this Society, which in 1838 promoted the first of a series of expeditions for the exploration of that continent. In the middle years of the nineteenth century the Society awarded four Gold Medals of the Society to Eyre, Strzelecki, Sturt (to whom Mr. Abbott is related), and Leichhardt. A considerable impetus to Australian exploration was given under the Presidency of Sir Roderick Murchison, particular attention being paid to the survey and settlement of the north-west coast. Mr. Abbott will be paying particular attention to the possibilities of developing the Northern Territory and to what its development may mean to Australia and to that greater community, the British Commonwealth, of which it is part.

Mr. Abbott then read the paper printed above.

THE HIGH COMMISSIONER FOR AUSTRALIA (The Hon. J. A. Beasley) paid warm tribute to Mr. Abbott for his address and said that he wanted to stress the special significance of the Northern Territory for the British people at the present time. Great Britain had ended the war with her resources severely depleted, yet here, within the bounds of the British Empire, was a vast land of opportunity awaiting British ability to develop it. A tremendous struggle for world supremacy was now in progress, and in that struggle resources were a primary factor. Great Britain was no longer strong enough alone to carry the burden of her responsibilities. Instead, the resources of all parts of the Empire must be held in common and used for the restoration of the whole.

At one time Australia had regarded her vast open spaces as a form of security. The war had proved that they were a danger to her, and would continue to be until they were successfully settled. So long as vast areas of her northern territories remained virtually unpeopled, she would be exposed to invasion from the north, where teeming millions were at her door. These changes could not be made over-night and plans must be carefully laid. Mr. Beasley felt certain that Mr. Abbott had made clear the urgency of the problem in his talk, and he wished him all success in his mission.

The PRESIDENT: Mr. Abbott has made his case with force and conviction, as he will have realized from the attention which he has been given by all here, and Mr. Beasley's comments have been a fitting addition to Mr. Abbott's talk. We now know that we have a great opportunity in the Northern Territory, and that it may be connected with the solution of some of Europe's problems to-day.

Mr. HENRY M. ANDREWS writes: The paper read by Mr. Aubrey Abbott contained the most clear and the most impressive statement to be found anywhere of the great opportunities which the Federal Government of Australia

has the power to create in the Northern Territory. The subject is so wide that Mr. Abbott found it convenient to omit any mention of a number of implications of these developments. But one consequence of the public works he envisaged is so far reaching that I hope you will allow me to draw attention to it.

Mr. Abbot pointed out the importance of irrigation and water conservation works, the need for investigating the Roper River valley with a view to irrigation settlement, and for investigating the Katherine Gorge for hydro-electricity. These are examples of the public works which it is confidently believed would open up opportunities for rice growing on a large scale, the cultivation of citrus fruits and vegetables with their concomitant canning industries, an extension of grazing, and the introduction of ground-nut cultivation. Certain technical difficulties would have to be overcome and, as Mr. Abbott pointed out, it could not be expected that firms would commit themselves to long-term plans without being assured of security of tenure.

It must be remembered that the Territory is a tropical country. The possibilities for cultivation and for the employment of immigrant labour which such public works would create are very great. It cannot be expected that a large proportion of this labour will be English, and if Australia maintains her White Australia policy, as it seems certain she will, she will in this connection require large numbers of immigrants from Southern Europe. For this reason these developments may assume an importance far beyond immediate Australian interests. The over-population of Italy is likely, during the coming generation, to become the most dangerous political dynamite in Europe. Italy cannot support more than her present numbers. She is losing her colonies and her people are very prolific. The pressure of over-population will lead to a new form of aggressive dictatorship unless it is possible to provide an outlet abroad. If Australia, in her own interests, found it expedient to develop her Northern Territory by opening the door to large numbers of Italian workers and their families, she would come to play a major part in a major European political problem.

While the public works which may provide these great opportunities and the whole policy of developing the Northern Territory are, of course, solely the concern of the Federal Government of Australia, it is hoped that it will be appreciated in Australia how great will be our interest in these matters, not only as providing an opportunity for our own people but also on account of the concern in the Italian problem which we share with the Governments of other countries.

WHALING FROM THE AIR

JOHN GRIERSON

Evening Meeting of the Society, 2 June 1947

MANY PEOPLE WERE surprised, even shocked, when they heard that aeroplanes were to be used by the factory ship *Balaena* to help in the chasing and killing of the whale. For the alarming decline of the whale population had already been noticed in the early 'thirties when nearly 35,000 blue whale units were being taken every year and a steady reduction in the average length of both blue and fin whales was occurring. However, protective measures had been started by the drafting of the Convention for the Regulation of Whaling, subscribed to by twenty-six contracting states of the League of Nations at Geneva in 1931, and ratified by His Majesty's Government in 1938. As a result, international control of killing was enforced, and in the 1946–47 whaling season the limit was set at 16,000 blue whale units for the combined whaling fleets and land stations. A blue whale unit is one blue, two fins, or two and a half humpbacks.

Blue, fin, and humpback are baleen whales. That is to say, they feed on shoals of a small shrimp-like organism called krill; their mouths contain a hairy material, baleen, instead of teeth and their throats are grooved to allow for expansion when scooping in food. They arrive in the Antarctic from the tropics in a very thin state, so that their blubber is apt to be disappointing at the beginning of the season—which in normal times lasts for three months but has now been extended to four because of the world famine in fats. By February however there is a pronounced improvement in the oil yield per whale due to their fatness after dining on antarctic fare. The oil of baleen, or long whales as they are sometimes called, is edible and is largely turned into margarine, whereas the oil of the sperm is not eaten but is used for such purposes as manufacturing lubricants, candles, and cosmetics.

The economic value of the whale has in the past been based almost exclusively on its oil but now, with more elaborate factory ships, the tendency is to develop the by-products—meat-meal for cattle feed, bone-meal for fertilizer, bullion for flavouring soups, liver oil for vitamins and, of course, the meat itself as food. It may even be possible to add the whale's blood to the list if economical ways can be found of dehydrating and storing it for use as fertilizer.

The war gave the whale a much needed holiday, and when the world whaling fleets attempted to restart operations in 1945 it was the fleets which were suffering from depleted numbers. Twenty-five factory ships had been sent to the bottom and supplies of gear and tackle had been lost or dispersed. Small wonder therefore that the yield of the 1945–46 season was poor. But by 1946 the equipment position had somewhat improved, although the addition of four new factories and one converted oil tanker still left a deficiency of twenty ships compared with pre-war, a deficiency which obviously could not be made good for several years to come. In the meantime, the world famine

in fats made it imperative that the largest possible amount of whale oil and by-products should be obtained at once. Every device for increasing the efficiency of the reduced fleet had to be explored. So it happened that Mr. Trouton, the chairman and managing director of United Whalers Limited, set out to apply such a modern invention as the aeroplane to such an old-established industry as whaling.

In 1929 a rather half-hearted attempt had been made by the Norwegian Cosmos Company to use a seaplane for whale spotting. The machine was a Gipsy Moth carrying no wireless gear at all, and after two or three short flights it took off and disappeared, never to be seen again. This was the only previous use of aircraft from a whaling ship, and there was consequently no practical data available in 1946 when I was approached by Michael Daunt, the air adviser to United Whalers, with a view to my taking charge of the flying operations from the factory ship *Balaena*, then building at Harland & Wolff. She mounted on her stern a hangar for two Walruses along with the cordite catapult and aircraft crane from H.M.S. *Pegasus*. As test pilots, Daunt and I had been associated in developing the first jet aircraft at Gloucester, and although the change from Meteors to Walruses seemed a humorous contrast, we looked upon the new undertaking as just one more programme of test flying.

The principal objectives were to reconnoitre the ice and the weather, and to try (without any certainty that we should succeed) to spot the whales from the air. Information concerning the thickness and outline of the pack, the promontories and bights, might save the captain of the factory ship valuable hours or even days of unnecessary steaming, and might also indicate the best positions for shelter in the event of stormy weather; there was too the possibility that whales or krill might be seen in the lakes of clear water inside the ice pack and even negative information on this point would be useful if we could first establish the "seeability" of whales. As for the weather in the Antarctic, this was known to be of a very local character, and with aircraft we might be able to find good weather within easy range of the factory. If the whales could be seen from above, then it should not be difficult to direct the whale-boats towards them by means of wireless or by visual signals.

Balaena, 15,760 tons gross, is one of the largest whale factories afloat. Besides carrying aircraft she incorporated a number of other novel features such as a quick-freezing plant for meat, a liver-oil extraction plant, a turbo-generator, and the largest meat bullion plant ever installed in a ship. A laboratory was provided for three Cambridge scientists to carry out investigations on whale-meat and other aspects of the whale's internal organism.

Our active preparations were made over a period of nearly eight months at the Saunders-Roe seaplane works at Cowes in the Isle of Wight. Here four Walruses, bought from the Admiralty, were completely overhauled, modified, and granted civil certificates of airworthiness, this being the first occasion on which the veteran of the Fleet Air Arm and of Air Sea Rescue work made its appearance as a civil aeroplane.

The two particular emergencies we visualized were, first, a landing in the open sea away from the ship and, secondly, a landing on or near the ice; in either case the loss of the aircraft had to be allowed for. For landing in the sea we

carried the normal inflatable dinghy, specially modified to protect the crew from exposure. On the advice of Surgeon Lieutenant Gabb of the Royal Naval School of Aviation Medicine we had inflatable double bottoms and flaps fitted, the latter being secured to a pole to form a tent. Much thought was given to the provision of dinghy rations, first-aid outfits, drinking water and de-salting kit, heliographs, distress signals, fishing kits, and so on. An aircrew should have been able to survive in the dinghy for anything up to a week, even in the Antarctic.

For landing on the ice we had special double pyramid tents made on the advice of Mr. Wilfred Hampton. The complete tent weighed 17½ lb., would accommodate three men in sleeping bags, and was found very warm to sleep in when we tried it out in England. Sleeping bags of R.A.F. pattern, having real eiderdown quilts and no zip-fasteners, were chosen and to these we added inflatable mattresses carried in an envelope sewn to the bottom of the bags. The inflatable element added comfort as well as insulation from the ground, and the complete bag weighed 12½ lb. For camping rations we were fortunate in obtaining the actual dehydrated foods carried by the Lancaster *Aries*, thanks to the cooperation of the R.A.F. Institute of Aviation Medicine and of the Low Temperature Research Station at Cambridge. Packed in special tins, five to each aircraft, this ration provided a varied diet for 30 man-days at 3500 calories per day for a total weight of 63 lb.

In order to establish wireless communication after forced landing, each aircraft carried a "Gibson Girl" hand-generated emergency transmitter. The emergency pack included a collapsible kite, balloons, and hydrogen generators so that an aerial could be mounted in either calm or windy weather. One more emergency device was a parachute supply-dropping container. This was made for us by the G.Q. Company, and we carried out successful dropping tests with a 50-lb. load under the aegis of the Airborne Development Unit at Beaulieu.

The aircrew's protection and comfort in the air were catered for in the first place by adopting the Naval Immersion Suit as our standard dress. This suit was developed by Squadron Leader Pask of the Institute of Aviation Medicine, and manufactured by Messrs. Frankenstein for the particular purpose of saving the lives of airmen on arctic convoys when forced to ditch. Made of a special cotton fabric which is porous when dry but immediately becomes water-tight through shrinkage when wet, this immersion suit will keep the wearer dry and prevent that rapid shock which is fatal within a few minutes when a man in ordinary clothing is flung into icy water. I made the first test by jumping into the Solent in February and swimming around for twenty minutes. The suit gave good insulation and only minor improvements were found necessary to fit it for all our needs. The Naval Immersion Suit was the outstanding success in our safety equipment. Although it is somewhat cumbersome to put on, the aircrew soon became accustomed to it and the benefit to morale was inestimable. When worn with submarine underwear, the suit was not too bulky and kept navigator and wireless operator reasonably warm even when the machine was unheated.

Inside the immersion suits we fitted electrically-heated body-liners, bootees, and gauntlets. We were not sure whether electric heating would be necessary,

and of course it was realized that unplugging and replugging would be inconvenient for the wireless operator and navigator who have to move about during flight. As an extra safeguard therefore, and as an experiment, we fitted one machine *Boojum* with a petrol combustion heater so that the air throughout the aircraft could be warmed. With regard to the crew's internal comfort, vacuum flasks of hot tea, slabs of Kendal mint cake and chocolate, and ham sandwiches composed our normal flight rations.

As befitted the most difficult exercise involving the use of aeroplanes from a ship—indeed the first occasion on which civil aircraft have ever been launched from and recovered by a British merchant ship—we depended heavily upon the Admiralty, not only for supplies of material but also for trained personnel who were experienced in operations of this sort. All the aircrew, with the exception of myself and one Norwegian wireless operator, and all the regular flight-deck crew except the two Saunders-Roe engineers had been trained in the Naval Air Arm. Their Lordships even lent us Leading Seaman Rogerson, probably the best crane-driver in the Royal Navy.

Throughout the period of preparation we had the assistance of a great many individuals, institutes, and government departments apart from those already mentioned. The individuals are too numerous to name, but I should like to acknowledge our gratitude to the Ministry of Food, who armed us with impressive priorities and guided us from one government department to another; the Air Ministry who allowed us to buy service flying clothes; the Ministry of Aircraft Production, who helped us with dinghies and parachutes; and the Royal Geographical Society, the Scott Polar Research Institute, and the Discovery Committee who all gave advice freely from their unique funds of experience.

The aircrew which I selected from nearly two hundred applicants consisted of Flight Captains Nigel McLean and Geoffrey Collyer, Flight Navigator Officers Hugh Milroy and Martin Routh, and Flight Radio Operators Leslie Holmes and Arne Horgen. Apart from flying and directing-officer duties, McLean ran the hangar and Collyer was our photographic officer. Milroy, besides being an expert on compasses, was responsible for all safety equipment such as immersion suits, parachutes, and emergency gear. Routh interested himself in birds, lice, and nature study which enabled him to bring back much data of a unique kind. Holmes proved adept at navigating as well as wireless operating, and he assisted the met. officer in his spare time. Our flight deck crew was composed of the catapult engineer officer, Bill Mitchell, two Saunders-Roe and one Bristol engineer, and our crane driver, the last four all being borrowed. In addition we borrowed helpers from the ship's company. One of our most successful recruits was an ex-R.A.F. sick-berth attendant who worked the catapult controls. A seaman rigger helped with the crane, and two ex-lumberjacks carried out the maintenance and adjustment of the catapult.

After months of training (which included courses on engines, dinghies, immersion suits, wireless, whale recognition, and parachutes), flight trials, and tests of equipment (we even won the Folkestone Trophy Air Race at a speed of 121 m.p.h. with one of our Walruses) we assembled at Southampton on 13 September 1946. From there we flew our three amphibians *Moby Dick*,

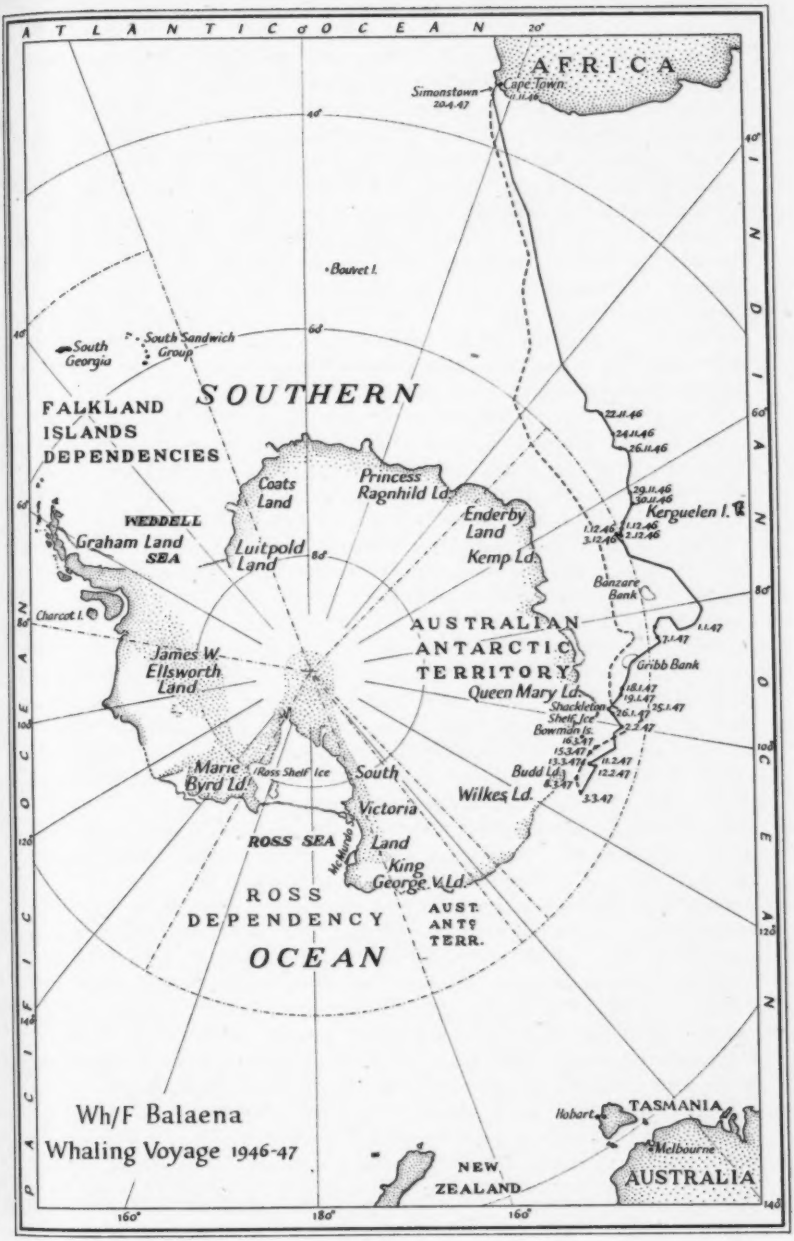

ATLANTIC OCEAN
AFRICA
Simonstown
20.4.47
Cape Town
1.11.46
Bouvet I.
South Georgia
South Sandwich Group
SOUTHERN
FALKLAND ISLANDS DEPENDENCIES
WEDDELL SEA
Graham Land
Coats Land
Luitpold Land
Princess Ragnhild Ld.
Enderby Land
Kemp Ld.
Charcot I.
James W. Ellsworth Land
AUSTRALIAN ANTARCTIC TERRITORY
Queen Mary Ld.
Shackleton Shelf Ice
Bowman Is.
Gribb Bank
Banzare Bank
Kerguelen I.
22.11.46
24.11.46
26.11.46
29.11.46
30.11.46
1.12.46
2.12.46
3.12.46
1.1.47
7.1.47
18.1.47
19.1.47
25.1.47
26.1.47
2.2.47
15.3.47
16.3.47
13.3.47
11.2.47
12.2.47
8.3.47
3.3.47
Marie Byrd Ld.
Ross Shelf Ice
South Victoria Land
Wilkes Ld.
Budd Ld.
ROSS SEA
Mt. Melbourne
King George V Ld.
ROSS DEPENDENCY
AUST. ANTC TERR.
OCEAN
Wh/F Balaena
Whaling Voyage 1946-47
Hobart
TASMANIA
Melbourne
AUSTRALIA
NEW ZEALAND
INDIAN OCEAN
PACIFIC OCEAN
20°
40°
60°
80°
100°
120°
140°
160°
180°

Figure 1

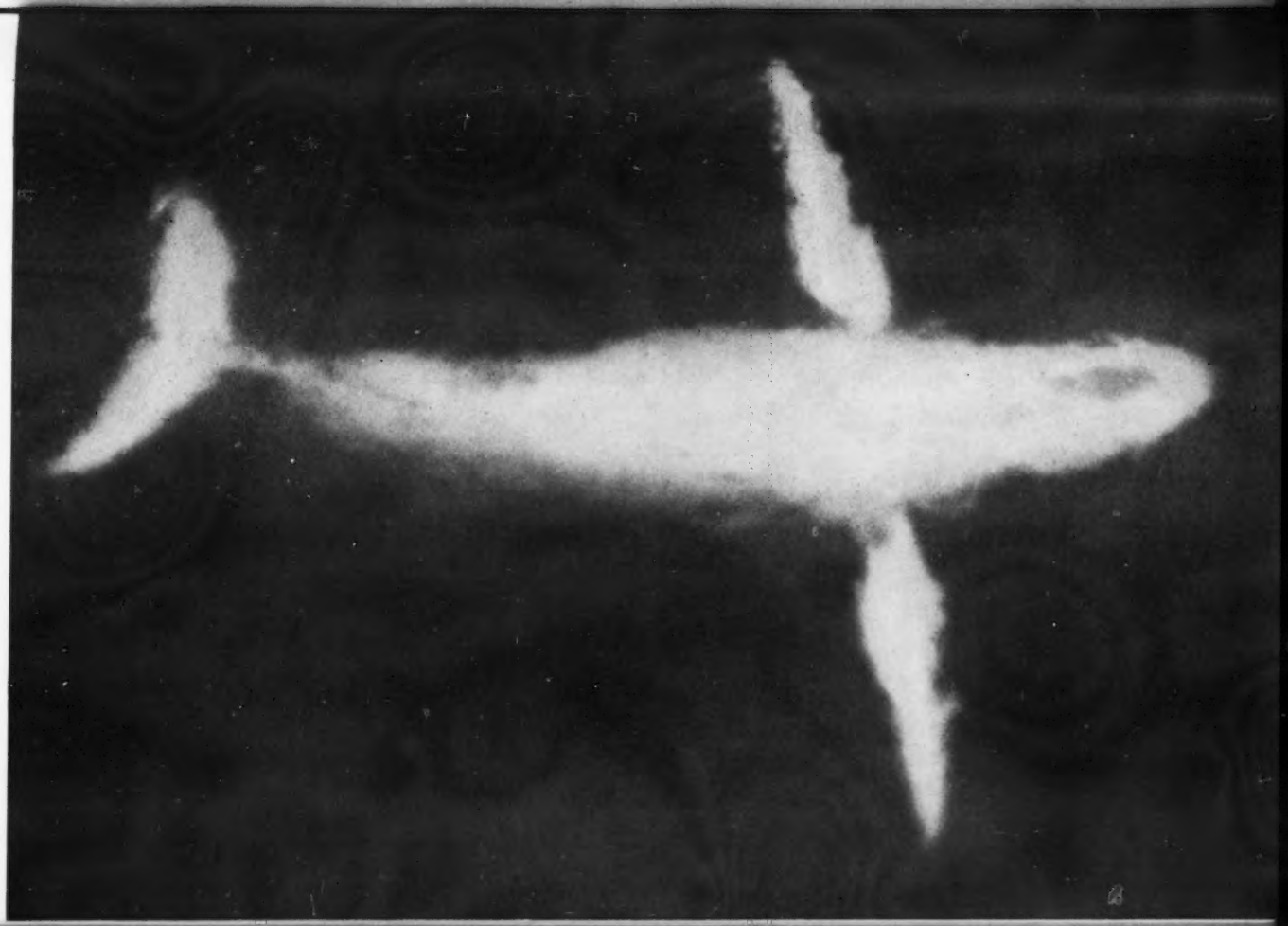
Snark, and *Boojum via* Dublin to Belfast, where we joined the *Balaena* which sailed on September 27. During the voyage to Norway we received training from Commander Walker, who was in charge of a team of naval instructors, and so completed all the preliminary launches and recoveries in Bangor Bay, the open Atlantic, and the North Sea without mishap. Had it not been for this initial guidance it would have been extremely hazardous, if not impossible, for us to have set out upon our enterprise.

Having taken on the Norwegian crew, we left Tonsberg on October 6. Between Las Palmas and Cape Town we decided to make some practice flights in the South Atlantic. On the very first of these, 25° S. of the equator, the aircrew reported a shoal of at least fifty sperm whales, and they found that even when the aircraft dived low over the water the whales took no notice of the noise. The sperm were easily identified, and calves could be distinctly seen swimming alongside their mothers.

We flew the three aircraft ashore to Cape Town while *Balaena* was still 200 miles out. Originally I had intended to take all three machines to the Antarctic—two in the hangar and one on the catapult—as a safeguard against breakages during recovery, but the aircrew had made the whole job look so easy that I decided to leave *Moby Dick* at Cape Town. This meant that all our maintenance on the two remaining aircraft could be done under cover. *Snark* and *Boojum* were taken to Youngsfield aerodrome in order to have their compasses re-swung, an essential adjustment after crossing into the southern hemisphere.

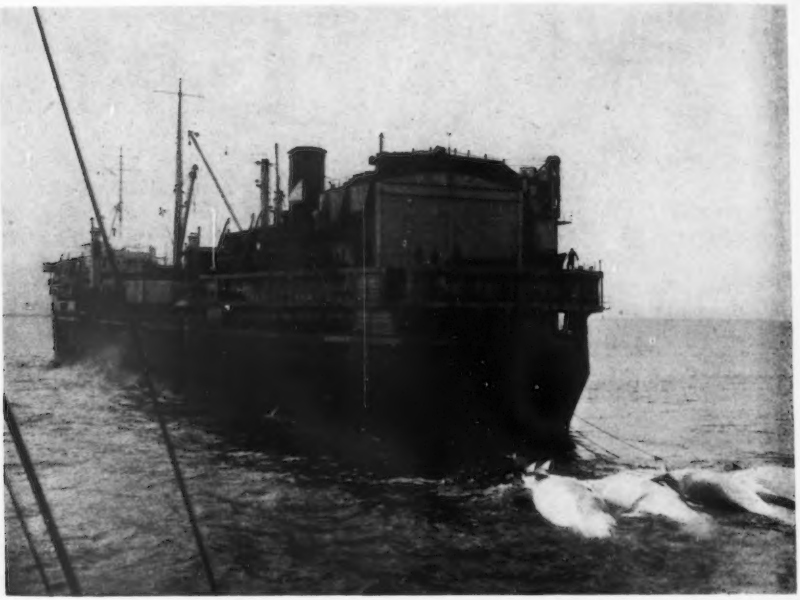
We now received a major setback, the end of a long-protracted struggle to obtain an American Radio Sector Homing Beacon. This equipment had been supplied to the British Navy under lend-lease during the war, and both our flight captains, being naval pilots, were experienced in its use. But because ours was a commercial purpose the U.S. Navy Department persisted in their refusal to let us use it, and our last hope of fitting it at Simonstown was dashed. We were therefore driven to rely only on wireless D.F. bearings, radar fixes up to 30 miles from the ship, and the best results which the skill of our navigators could obtain in a region where the magnetic compass had a bad reputation on account of the proximity of the Southern Magnetic Pole. Another disappointment was over the question of outside help for our meteorology, vital for the purposes of flying. The Air Ministry had lent us a senior meteorological officer, Hugh Lamb, and his work was to be correlated with reports from the other whale factories. The British, Norwegian, South African, and Dutch governments had all agreed to the broadcasting of daily weather reports by their whaling fleets but in practice the British alone did so. Consequently we were deprived of information which would have added both to the accuracy of our forecasts and to the safety of our operations.

Since sperm whaling in the Antarctic is not restricted to a season like baleen whaling, we were able to do three weeks "working the ship up" on sperm before the baleen season opened. Our first sperm was drawn up the slipway in *Balaena's* stern at two o'clock in the morning of November 18 about 2000 miles south-east of Cape Town. But it was not until the 22nd that we had our first chance to fly; that was to make a weather and ice reconnaissance at 55° 50′ S. 48° 55′ E. On the 25th we carried out the first air-directed hunt and



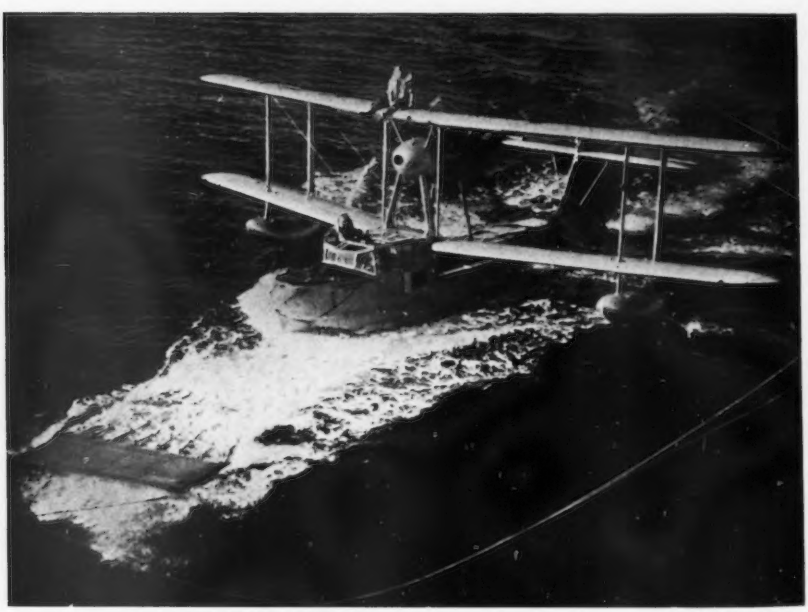
Humpback whale from the air, distinguished by great length of flippers and showing how these are stretched at right angles to the body when swimming

Phot. from J. Arthur Rank's "This modern age" issue "Antarctic whalehunt"



Phot. by courtesy of J. Arthur Rank

Wh/F Balaena with whales in tow



Phot. R. A. M. Case

"Moby Dick" being picked up by "Balaena" using a rope mat

kill of a whale, and there followed a period of twelve days when we flew almost every day, spotting sperms for the catchers and directing them to the kill. The ten catchers or whale-boats which worked with *Balaena* are vessels of 300–600 tons gross with a speed of 12–16 knots. Their bows are high so as to give the whale gunner a good platform from which to shoot his harpoon, and the foremast serves both as a mounting for the crow's nest and as a support for the pulleys taking the harpoon lines to the steam winches. These pulleys are controlled in their vertical movements by powerful springs under the deck, which safeguard the tension on the lines from sudden shock-loads. The catcher's aims are to hunt the whale, to chase and harpoon it, which requires both speed and very rapid manoeuvrability, and to tow the catch back to the factory.

The method we used worked in the following way. The aircraft would leave the factory and fly towards the area where the greatest number of catchers were known to be concentrated, which would be from 10 to 50 miles away. This area would be reconnoitred at a height of 1000 feet until a sperm was spotted. There were three possible ways in which his presence might be evident: by his forward-slanting blow, by his "footprint" or "slick," a mark left on the surface of the water where he had recently been swimming, or by the outline of his body, clearly visible to a depth of about 30 feet below the water. If a catcher was very near, the aeroplane would promptly dive low on a parallel course over the spot where the whale had been seen. If no catcher was at hand, the aircraft would first mark the whale with a sea-marker, then fly to the nearest catcher, make a circuit, and, by waggling its wings, indicate the direction of its find.

We carried three types of marker, two giving smoke for 150 and 6 minutes respectively, and the other a dust-marker of aluminium dust and fluorescene which we had developed at home. On one occasion the navigator, Jock Milroy, landed a dust-marker plumb on the back of a sperm, an incident which seemed to trouble the monster very little. We generally used a smoke-marker if there were no "enemy" catchers about. When competitors were within sight we employed the dust-marker, which can only be seen at a distance from the air, and then led our catchers up to it. After this, unless we were exceptionally lucky, there began a vigil or succession of vigils, with the aircraft always in close attendance on the catcher and with three pairs of eyes concentrated on a circle of about 2 miles' radius in which the whale was last seen to sound. We timed sperms to sound for anything up to 45 minutes. If the whale swam beneath the surface of the water, we could see and indicate to the catcher any changes of course when it was quite impossible for the catcher's crew to detect them.

While sperm fishing, the aircrew were all impressed by the ease with which whales could be seen under water and by the very graceful movements of these huge animals, especially the deflection of the flukes at the beginning of the sounding dive when the body seems to assume an angle of about 60°. We made nine flights giving direct assistance to the catchers, totalling 38 hours 40 minutes, during which we spotted twenty-one sperm and thirty-four other whales. The gunners confirmed that the aircraft had been responsible for guiding them to the kill of nine sperm. We also directed the catchers to a

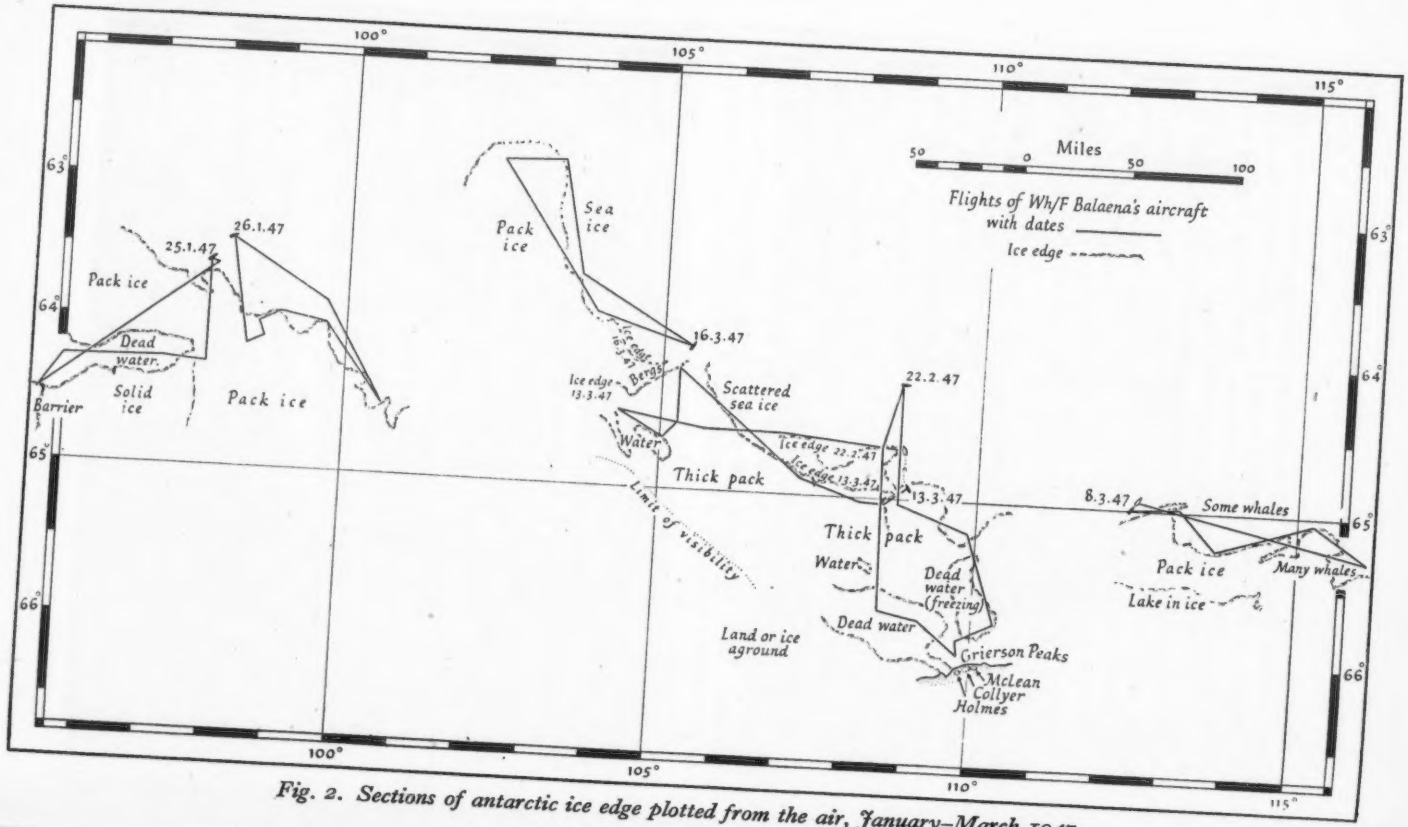


Fig. 2. Sections of antarctic ice edge plotted from the air, January–March 1947

spot where twenty-seven sperm were killed in one day and twenty-two the next. Other objects were achieved on these flights. For instance, we plotted the position of the ice edge (Fig. 2) and we reported the bearing, course, and speed of a competitive factory ship, the *Thorshammer*. The weather was generally fine but overcast. On one occasion some windscreen and wing icing was experienced, though not to a serious extent.

On December 8 the four-month season of baleen whaling opened and we transferred our attention from sperm to blue and fin whales. As a result of Dr. Fraser's whale recognition course in the Natural History Museum, only a short time elapsed on the whaling grounds before the aircrew became quite expert at knowing their whales.

Throughout December, and to some extent throughout the season, we were handicapped by a circumstance as fortunate for the whaling fleet and for starving Europe as it was unfortunate for those of us who wanted to prove the usefulness of aeroplanes: this was the abundance of whales. Naturally, when the catchers were rationed, as they often had to be in order to prevent them from killing more whales than the factory could deal with, there was not only no need for aeroplanes but it would have been inconvenient to have diverted labour for aircraft handling parties from the flensing deck or the factory.

When we were flying during the season proper, we seldom gave the catchers direct help but instead devoted most of our energies to ice reconnaissance. In this connection, useful results were achieved. Two flights were made to the Shackleton Ice Barrier or Shelf (Plates 4 and 5), possibly the first time this has been seen from the air. The cliff-like edge of the Barrier was reached after a flight of 70 miles across the pack and then over a lake of open water in the ice 30 miles wide. Although a few birds and seals were seen by the lake, there was no krill or sign of whales so that it constituted what is known to whalers as "dead water." The Barrier was found to range in height from about 50 to 150 feet, dropping sheer into the lake to the north, and falling to the east to a long stretch of continuous sea ice covered by wind-driven snow. Icebergs could be seen in process of calving from the Barrier and drifting northwards into the lake. On a subsequent occasion when a little farther east, we flew to within 6 miles of a point where the land was bare, and at 66° 10′ S. and 110° E. three black peaks about 1500 feet high were plotted.[1] By chance, several days later Hugh Lamb took bearings of some land he could see at a distance from the ship and his fix coincided with the position given by the aircraft. Although we thought we saw bare rock far away during other flights, this was the only occasion on which we could report it with certainty, both from the proximity of the aircraft at the time and from a subsequent cross-check.

A total of eleven ice sketches were made. These resulted in some cases from flights along the ice edge, and in others from penetrations of the pack up to 100 miles. Many lakes were explored, and our observations tended to confirm the belief current amongst whalers that, whereas blue whales used formerly to be found in numbers in lakes far from the ice edge throughout the season, they now rarely enter the ice to any great extent until March. Once we

[1] These have since been named "Grierson Peaks," and individually "McLean," "Collyer," and "Holmes" after the members of the aircrew, by permission of the Australian Commonwealth Government.

saw a blue whale disporting itself and rolling over in an opening in the pack barely more than twice its own size.

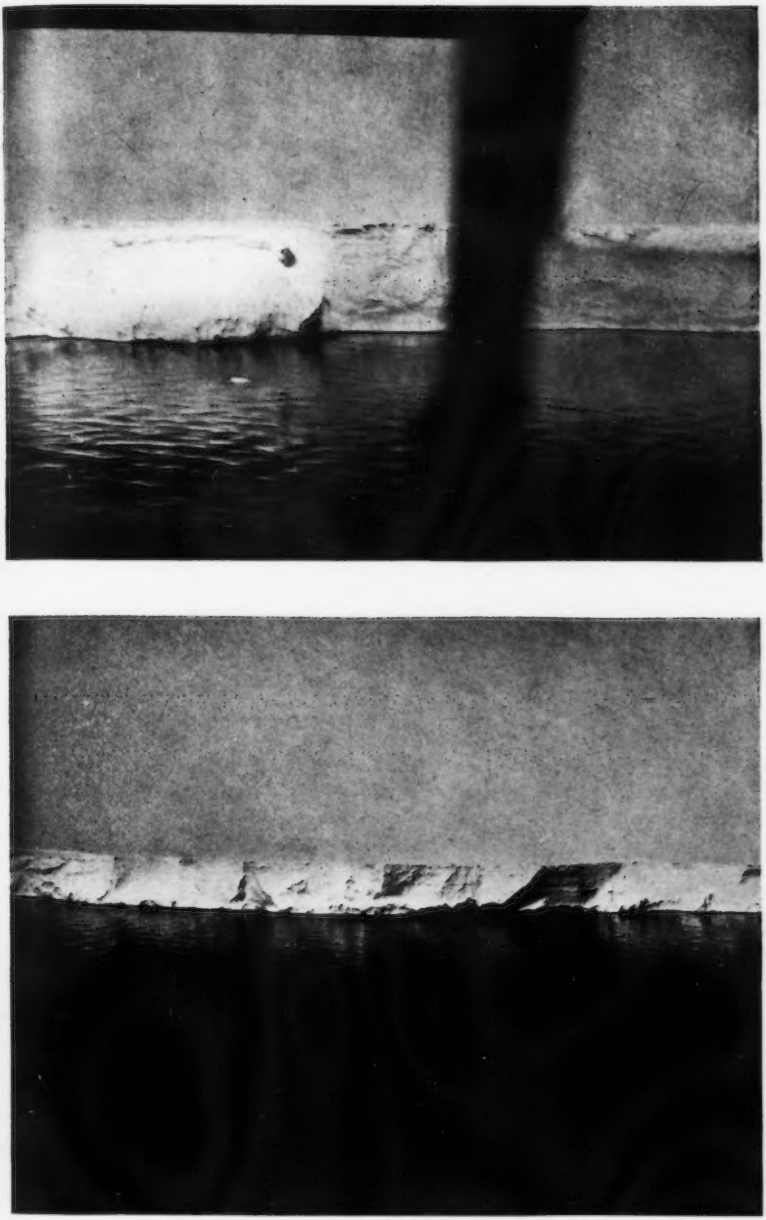
Our ice sketches were of value to the whaling captain in several ways. One day, after flying eastwards along the ice edge, we found the competitive factory *Norwhal* 61 miles away with no whales on deck or in tow; that was a day on which we ourselves took fifty whales. On several occasions we shadowed the *Norwhal* and reported her movements. We could see easily which bays in the ice had enough whales to be worth visiting and which would provide the best shelter from swell in the event of a storm. One bay which we had plotted was used for the delicate operation of bringing the oil-tanker alongside with three whales as "fenders" or shock-absorbers between the two ships.

Two tankers made contact with *Balaena* during the season, one just before Christmas and the other in mid-February. They brought mail from home and were a welcome link with Cape Town. The transfer is a difficult operation even in fine weather. On one occasion I was standing on the flight deck with the aircrew watching the arrival of the *Sysla*. As she closed in towards us her bows grazed ours and she put her engine full speed astern. The stern came towards us at an alarming pace and we all held our breath for the impact which seemed likely to make a nasty dent in *Balaena* just forward of the flight deck. But luckily *Sysla* struck our aft fender whale fair and square. With an almighty pop the whale exploded, its entrails being flung high into the air. There was a terrible stench but the whole shock had been absorbed and we could hardly feel any movement by *Balaena*.

Once alongside, the tanker pumps her fuel oil into the factory, casts off, and then spends two or three weeks cleaning out her tanks before filling up with whale oil and by-products. The avoidance of swell during these transfers is most important since if it becomes too heavy the tanker has to be cast off and this entails an expensive delay.

Another of our ice sketches showed a stretch of the ice edge running due north for nearly 100 miles. On this sketch the ship was navigated to cut the corner of a large bay. During one flight across the ice, we saw two dead blue whales, and a gunner who happened to be our passenger on this flight afterwards took his catcher into the ice and brought in these whales which would otherwise have been wasted. We found that whales could be seen quite easily, whether they were on the surface or under water, from as great a height as 10,000 feet. The amount of detail visible under water was surprising and on one occasion fin whales could be seen "swaling" or scooping up the krill, and rolling over on their sides as they did so, at a great depth beneath the surface.

Before going on to some of the more technical details of our operations, I should like to describe briefly the way in which our allies, the whale-boats or catchers, worked. I was so fortunate as to go out for a few days with Gunner Borgan, one of the old hands on the catcher *Terje 3*. We started work at four o'clock in the morning, after steaming along the ice edge to a spot where plenty of fin whales could be seen blowing. Having chosen three fins, we began chasing them and gradually closed the range, but the matter was complicated by the arrival of three more fins. It is the gunner's business always to pick the largest animal, which calls for considerable experience. Presently Borgan levelled his gun, there was a terrific bang, and the harpoon tore into



Shackleton Ice Barrier from the air in 64° 35′ S., 95° 10′ E. in January: above about 200 yards, below about 400 yards distant

the back of a fin barely 40 yards distant. Out ran the line for a minute or two until the winch started to heave in, the winchman watching the spring-loaded pulley on the mast so as to gauge how much strain he was putting on the line. The whale could be seen surfacing and blowing about half a mile ahead, and as it turned over we saw a red gash in its side from which blood was pouring, leaving a crimson trail in the sea. At close range the whale was impaled by another harpoon, as owing to the fatness of the beast, the first had gone right through and out the other side before the time-fused grenade had exploded, so failing to make a lethal impression upon the whale's interior. The result of the second harpoon was a fairly speedy end and the whale went into its flurry, threshing the sea with its tail as it died. About twenty minutes had elapsed between the first shot and the reeling in of the carcase across our bows. The next step was to insert a steel tube into the belly, now uppermost, and inflate the whale with compressed air to keep it afloat. A strop with a wooden float attached was then passed around the tail, the ends of the flukes were chopped off, and a red flag with the company's initials and the mark of *Terje 3* was firmly implanted.

Such is the normal procedure for chasing and killing a whale. Unfortunately I have no time to relate more exciting contingencies—when the harpoon line fouls the propeller shaft, when the whale takes it into its head to ram the catcher, or when the heat of the chase leads the gunner on at full speed into the pack ice with disastrous consequences to the bows or propeller. The professional whale-gunner must be a first-class seaman, he must have a natural instinct for finding whales coupled with an uncanny sense of direction, and above all he must have infinite patience. The manner in which catchers find their flagged whales dotted about the ocean, sometimes with the aid of a rough sketch of the shape and bearings of the nearest icebergs but often without such aid, is all the more wonderful in view of the unreliability of the catchers' compasses. These instruments are not infrequently used as ash-trays or stands for mugs of tea, and the principal direction guide is the wind. The gunners rely on the factory ship, which is equipped with a gyro, to tell them the wind direction by radio.

Many of the gunners were very doubtful about the practicability of aircraft in whaling, but they began to be impressed on seeing McLean land smoothly in a 200-foot swell with 12-foot waves at the end of a practice flight between Las Palmas and Cape Town. When we proved that we could also spot whales and direct the catchers to them, one old gunner went so far as to say, "This is the finest thing that has ever happened in the Antarctic!"

In all we made twenty-three flights over the whaling grounds, totalling 96 hours 10 minutes. Our longest flight lasted $5\frac{1}{2}$ hours and the greatest range at which we operated from the ship was 125 nautical miles; this could safely have been extended to 200 miles had the ship been fitted with the radio sector beacon. We were fortunate in completing our season's work with only two mishaps, thanks to the skill of the aircrew and flight deck crew and to a generous share of luck. One was of a very minor nature when a propeller tip was fractured by the hook of the crane. The other was when Collyer was forced to land in the open sea by a sudden blanket of fog and snow which cut him off from the ship. That day the ship was steaming through an area thickly

studded with icebergs, one of which had been checked at 350 feet high by the aircraft flying alongside. Consequently the risk of flying low in bad visibility was extreme. The icebergs also caused false echoes on the radar, and our only radar bearing of the machine at close range turned out to be a reciprocal. Fortunately the weather outside the snow-belt was clear, and there was no small ice in the sea where the machine landed 23 miles from the ship. D.F. bearings were taken both before and after landing so that the factory and two catchers could make for the spot at once. In the meantime the aircraft started to taxi towards us at 3 knots, the crew arranging themselves in watches—one steering, one keeping an ice look-out from the top of the wing, and the third member resting in one of the inflatable sleeping bags. After an hour and a half the sea became thickly strewn with ice and they were forced to seek shelter in the lee of an iceberg. The engine was switched off and drogues were streamed; here the pitching of the machine in the swell became more pronounced and the radio operator began to feel sick. They drank some water but did not feel like eating; they felt most the lack of cigarettes (which were subsequently included in the emergency rations). By the time the ship arrived darkness had fallen so that the aircraft had finally to be located by means of Verey lights and distress flares. Just before midnight, in a snowstorm and with chunks of ice banging against the hull and floats, the machine was safely recovered. This was all the more remarkable in that we had never contemplated having to recover an aircraft in the dark and all the lights had to be rigged up at the last moment. Fortunately McLean, the directing officer, had actually carried out night recoveries in the Navy and he made the task appear like an everyday operation.

From November 18 to April 7 the weather was remarkable for the number of really fine days suitable for flying—53½ out of 141. I was most surprised at the absence of cold; the temperature was generally just below freezing and we never had more than 11 degrees of frost. There was at least as much sunshine as in an average English summer; we only had three gales and visibility was generally either very good or else too bad for flying. We found that sudden changes could take place, as in the case of the forced landing, but by keeping a good look-out from the ship we were normally able to recall aircraft in time for a safe landing. Hugh Lamb gave us a notably good forecast service, an achievement all the more remarkable in that his nearest outside observations often came from stations 2000–6000 miles away. We for our part were able to help him to some extent by bringing back from every flight a detailed report of visibility, cloud formations, icing conditions, wind, swell, sea-ice, and air temperatures up to 10,000 feet whenever the weather was fit for a climb.

Photography was not added to our list of duties until rather late in the period of preparations, with the result that arrangements had to be made hurriedly at the last moment. The F.24 camera we carried was really too complicated and unwieldy for our purpose, but in spite of this and of the fact that he had never had any special training, Collyer as our photographic officer produced some useful results. We were helped considerably with our photography by Doctor Bob Case, chief of the Cambridge scientists. He also helped us by analysing our aviation fuel when we suspected contamination. On a future occasion, vertical overlapping photographs should be tried for mapping

the ice, but on the whole I doubt whether this will produce results more acceptable to the whaling captain than the navigator's free-hand sketches.

Navigation turned out to be much easier than had been expected because of the excellent performance of our unstabilized magnetic compasses which had been specially mass-compensated to the instructions of the Admiralty Compass Observatory. Even at 65° S. 116° E. where the variation is 60° and the earth's horizontal component ·07 gauss, on a southerly course the needle took just over 30 seconds to settle after a deflection of 45°. On one or two occasions we had reason to suspect slight local interference. The taking of drift sights whilst flying over the pack was difficult because the dust-markers refused to burst on impact with the soft snow and the white smoke of the smoke-markers was easily lost. A smoke-marker giving orange smoke would seem the best answer to this. Our intention to use astro-sights and sun-compasses was prevented by the failure of the new *Air Almanac* to arrive from England; unfortunately this was not printed until the end of the preceding year, too late to reach us.

Our naval radio sets, the A.R.I. 5206, gave very satisfactory results with a normal R.T. range on high frequency of 80 miles, and on morse the strength was such that we could have worked up to 300 or 400 miles' range. We had some trouble with erratic reception due to sun-spot interference during one or two flights, but this was only of a temporary nature. D.F. bearings within 5° accuracy were obtained at 90 miles. For radar, the Mark II I.F.F. responder beacons, working in conjunction with the 292 transmitter-receiver in the ship, were of some assistance. The principal difficulties were the reduced range when we were forced to fly below 1000 feet, interference caused by icebergs, and echo errors when the aircraft was close to the ship.

Snark and *Boojum*, designed by Vickers Supermarine, manufactured by Saunders-Roe, and driven by Bristol Pegasus engines, gave an account of themselves up to the highest traditions of the British aircraft industry. The fact that we had no trouble of any sort in the air was largely due to the very high standard of maintenance by our engineers and the hangar staff. The Walrus gave us very good service indeed, and even to-day, some thirteen years since it was originally designed, this machine is as good as any in the world for the type of work we were doing.

The future of aircraft in whaling is assured, but the lines on which they work may diverge somewhat from those of our experiment. The helicopter, when it has attained a useful range and load-carrying capacity and does not require too much maintenance, will certainly find a place in the whaling fleet. The elimination of crane and catapult will be a great saving and only a small flight deck will be necessary. Really long-range reconnaissances could only be carried out at present either by aircraft flying from an aircraft carrier, which could also be a supply ship for the factory, or by shore-based machines. The latter might conveniently fly from the meteorological stations which are likely before long to be dotted around the fringe of Antarctica. It might well be feasible to combine the objects of whale and weather long-range reconnaissance.

Another possible air development is the shooting, inflation, and marking of the whale by means of a CO_2-filled rocket projectile containing a

radar responder beacon. This would precipitate a revolutionary change in the whaling industry, from the whale gunner who steers a ship to the whale gunner who flies an aeroplane. I can hardly conceive that such a revolution would be tolerated!

DISCUSSION

Before the paper the PRESIDENT (The Rt. Hon. LORD RENNELL OF RODD) said: This evening's meeting is the last of the Session and is concerned with a subject which affects us all. We are to hear of the expedition of the whale factory ship *Balaena*, recently returned from the Antarctic, and the experimental use of aircraft in connection with whale catching. Whaling, remote as it may appear from the heat of this June afternoon in London, is so vitally connected with our food supplies that your Council have thought fit to ask the Minister of Food, Mr. John Strachey, to come as our principal guest this evening.

We are also very pleased to welcome here to-night Admiral Vedel, Commander-in-Chief of the Danish Navy and Vice-President of the Danish Geographical Society, whose guest your Director and Secretary and I have been in Denmark. Through him and his illustrious President, the King of Denmark, we made our first contacts with the Scandinavian Geographical Society. We have with us a number of other distinguished guests, some of whom have taken a direct part in the expedition, notably Sir Vyvyan Board of United Whalers and Sir Henry Self of the Ministry of Civil Aviation.

Mr. John Grierson then read the paper printed above.

The MINISTER OF FOOD (Mr. John Strachey): Mr. President, Ladies and Gentlemen, I have nothing to add to the fascinating story we have heard except to point the obvious moral that all the extraordinary devices and enterprise which we have seen, wonderful as they were to those who participated, are of even greater importance to us—and by "us" I mean every inhabitant of Great Britain. The expedition was not by any means enterprise for enterprise's sake. It has the prosaic but very vital importance of being a considerable factor in the size of our margarine ration, and that is something in which we are all at this time very much interested. It is notable that this was a great commercial enterprise run for the commercial interests concerned, but also run for the oils and fats which it could bring to a world sorely needing them and to this country which needs them no less than any other. We are all, I am sure, profoundly grateful to the men who conducted this enterprise; we also appreciate the ability, if I may say so, of British concerns to use new methods, to experiment with a quite untried aid such as aircraft in whaling. If this country is to live and eat—I emphasize "eat"—it will be by our people showing that kind of flexibility of method.

We are developing in another direction for the same purpose, the planting of ground-nuts in East Africa. That too is to augment our oil and fat ration. I think we shall need every ton of whale-oil as well as all the peanuts which we can grow in Africa—and every other source of oil and fats for that matter. It has been, I am sure you agree, most heartening this evening to hear of the very fine work which has been done.

Mr. HUGH LAMB: Mr. Grierson touched on my main difficulty as meteorologist of the expedition when he spoke of the failure of the weather reports which we had hoped to get from the other whaling ships in antarctic waters. Even if I had known that those reports were to fail I should have felt some diffidence in trying to draw weather maps showing the weather systems over such wide stretches of deserted ocean. The gap between the nearest reporting stations and

our ship was often of the order of 2000 or 3000 miles, and it was a surprise to me that the technique did work.

You may be interested in a few of the flying weather problems. These arise as a result of snow, bad visibility, and rising seas. Ice formation was avoided chiefly by not flying the aeroplanes in clouds. Snow and fog occurring in isolated patches were less important than a continuous line or belt of snow. We had to contend with both on different occasions, but whereas we might decide it was not advisable to fly if a continuous belt of snow was approaching, small patches of snow could be avoided unless there was any risk of the ship running into them. The very small-scale weather maps we had to use covered more than half the southern hemisphere. Obviously one could not fix the position of any individual system of snow or patch of fog to within a few miles on these maps; and if we knew the situation was such that there were patches of fog or snow about we used a special technique of restricted flying. The aeroplane would first go out to fix the position of the hazards that we were considering. It would then signal back to the base ship by radio telephone and we would decide on this basis how far it was safe to let the aeroplane go on its intended course before recalling it.

I might add that all through the period in the Antarctic I felt very grateful to John Grierson for his extreme cooperativeness and understanding in all kinds of situations and problems. This gave us all the advantage of flexibility of organization in meeting new problems.

The PRESIDENT: A point that has been brought out clearly both by the lecturer and by Mr. Lamb is the use of modern techniques applied to a very old and romantic industry which has been brought up to date by what we have discovered during the war and are now applying to the uses of peace. We have heard not only of the successes but unfortunately of certain failures—notably of the failure in the international cooperation which the members of the expedition had been led to expect. But we must agree that Mr. Grierson and his friends have demonstrated satisfactorily that the use of aircraft while not indispensable is of great assistance to whaling. We hope that all those interested in the industry will bear that lesson in mind for the future. I thank our lecturer on your behalf, and hope that he will find again that same enterprise and courage of which he spoke so lightly.

TOPOGRAPHY AND WEATHER IN THE ANTARCTIC

H. H. LAMB

Afternoon Meeting of the Society, 10 November 1947

YOU HAVE ALREADY heard a general account of the *Balaena* expedition from John Grierson, the leader of the air party on board. My duties as the meteorologist of the expedition were immediately concerned with the safety of this air party and with giving advice about the weather conditions and hazards to be expected whenever a flight was planned. It was for this purpose that United Whalers Limited, the owners of *Balaena*, had sought the loan of my services for the season by the Meteorological Office, Air Ministry. The Meteorological Office was specially interested for purposes of research in obtaining experience of synoptic weather conditions in high southern latitudes.

I was also to experiment with the possibility of providing weather forecasts of use to the whaling operations generally. The results of a series of daily forecasts for twenty-four to thirty-six hours ahead turned out better than had been expected. But I think that if we had been able to organize the use of the radio-telephone, so that the gunners on their whaleboats could inquire about risks of thick weather impending in the next hour or two when leaving flagged whales to go after further quarry, I might have been able to give more direct help. This new application of meteorology seems to have aroused the interest of the whale-gunners, but unfortunately circumstances have prevented us from carrying the experiment any further for the present. After a bounteous whaling season in 1946–47 which rendered spotting from the air largely unnecessary, *Balaena* is not carrying aircraft in the coming season and the loan of a meteorologist is no longer justified by concern with the risk to human life.

Observations of land

Balaena's voyage took her close to one of the least known sectors of the coast of the antarctic continent. I find that the sighting of the coastal mountains between 109° and 114° E. from the ship at distances ranging from 30 to probably 70 miles or more is mentioned in my weather diary on five days during February and March. It is interesting that in each case meteorological evidence was of use in either checking or adding precision to the observation of distant land, and it seems that a knowledge of meteorology may help the critical observer who is confronted with an appearance of land which is uncharted and unknown in a region where land may be presumed to exist. I think it will be worth while to give some consideration to these observations before going on to the actual meteorological work and its implications.

The Admiralty charts for the sector visited and the *Antarctic Pilot* make rather frequent reference to reports of an "Appearance of land" taken

from logs of vessels which have visited these waters. In some cases these reports are conflicting. In particular, there has been doubt about the authenticity of the Budd Coast, otherwise known as Budd Land, which was first reported in 1840 and is marked on the Admiralty chart in 65° to 66° S. and 110° to 114° E. This land was seen from *Balaena* on several days (Fig. 1), and its western end was reached by our aircraft on 12 February 1947 when they flew over a three-pointed hill of bare rock 1500 feet high about 66° 10′ S. 110° 00′ E. The approximate position and alignment of this coast indicated on the charts appeared reasonable.

Some erroneous reports and misleading appearances of land may be explained by optical effects connected with iceblink and certain characteristic alignments of cloud systems over the ice. Reflected light tinges the cloud white over extensive pack ice; and in dull, quiet weather under suitable conditions of light one may read a rough map of the ice from its reflection on the overcast ceiling above. Mirages, complicated distributions of ice, and tricks of varied lighting may however render the pattern on the cloud ceiling quite confusing. Again in late summer, when conditions are freest of ice for navigation and when vessels have most often visited these parts, there is often a strip of open water between the pack-ice belt and the coast. It seems certain that the dark strip on the cloudsheets above this water, contrasting sharply with the brightness of the cloud over the nearer icefields, has sometimes been mistaken by observers for the land itself. Another factor renders this mistake still easier; for meteorological reasons, connected with the circulation of air currents of unlike temperatures, the cloudsheets tend to align themselves parallel with the ice margin though their edges may be some distance either north or south of it. It is not uncommon to find the belt of pack ice, the coast to the south, and the strip of ice-free water between all broadly parallel to one another in an east–west alignment; and this general parallelism may be repeated in the structure of several overlapping cloudsheets at different levels in the sky above. Differences of lighting on successive cloud layers are then only too liable to give dark (or bright) strips near the southern horizon, looking very much like distant land (or the ice-cap gleaming in sunshine), in the very alignment which the coast would show if it were visible.

On 4 February 1947, before we got within visible range of the antarctic continent, we saw two dome-shaped masses of ice about 64° 00′ S. 100° 35′ E. and 64° 00′ S. 99° 40′ E. respectively (Fig. 1) which I took to be glaciated islands or reefs. (The positions are only good to 10 miles or so due to dead reckoning in overcast weather.) The evidence was not entirely conclusive; a whole array of icebergs and congested pack ice seemed to be stranded along an east–west line at this point, but the two domes were rather higher and differed in shape from the other ice. It is hard to see how a dome of ice several miles across and sloping away (so far as could be judged) on every side to the surrounding water could have arisen in this position far from the coast unless it were formed by glaciation of some rock core on the spot. The stranding of so much other ice in line with these two domes in any case suggests a submarine ridge close to the surface, and the existence of one or two small islands there would be quite likely. *Balaena*, steaming south towards this ice, took soundings of about 200 fathoms 14 miles north at 63° 46′ S., 100° 30′ E. decreasing

to only 46 fathoms at 63° 50′ S., 100° 18′ E., the nearest she went. These soundings are a good deal shallower than the existing charts would suggest, but the region is near the Bowman archipelago about which little seems to be known with certainty.

The first reference in my weather diary to the sighting of land which could be presumed to belong to the continent itself appears in the entry for 20 February 1947 when the vessel was about 64° 45′ S., 109° 30′ E., where it was observed that clouds near the horizon far to the south of the ship appeared to be dragging along a hillside. The forms of cloud distorted by friction against the ground are quite characteristic and are familiar to the mountaineer, in the mists that drive along a mountainside, as well as to the meteorologist. They may provide one of the most reliable indications of land in circumstances such as we found.

Two days later, on 22 February 1947, at a point near 65° S. 110° E. in brilliantly clear weather we could see the land low but bold along the southern horizon as a long, rather even-topped ridge of hills. In a broad gap in the line of hills stood a smaller three-pointed hill of striking shape, across the face of which drifted small tufts of cloud apparently formed by low fog dispersing under the warmth of the sun. Bearings taken on the hill from the factory ship gave a position about 66° S. 110° E., agreeing well enough with the position reported by our aircraft flying over a similar hill ten days before. For some time we did not notice this correspondence or realize from our position on the 22nd that it was the same rugged hill, whose existence was thus confirmed (see p. 41). It seems probable that the low mists reported by the aircraft to be shrouding the rest of this coast on the 12th hid from view all the higher ridges to the east and west later seen from *Balaena*.

The day on which these ranges were seen from the ship was one of extreme clarity, enabling us to see great distances, but we considered that the angles of elevation of the crests of these ridges of coastal mountains (amounting to no more than 15′ of arc) were not to be trusted in the likelihood of refraction (looming) effects. On the other hand, the small amounts of fractocumulus cloud present permitted a reasonable guess at the height of the highest ridge of hills seen. The diminutive clouds were scattered over much of the sky as the merest traces of a single, fragmentary cloud layer, extending from the zenith over the ship, where their height was about 3000 feet, south to the mountain-tops, where they clung about a few of the highest peaks. This observation helped to establish that what had been taken for a ridge of mountains was in reality so and not itself a cloud-bank; and it meant that 3000 to 4000 feet was the probable height of the highest peaks.

Two sketches (facing p. 52) of the coastal views seen this day were made with the aid of large-magnification binoculars to check details; and the bearings taken from the factory ship in various positions on this and other days were used as the basis of a sketch-map (Fig. 1) which in general confirms the indications on the Admiralty chart for this section of the coast and adds a little.

Our best view of long stretches of the coastal mountains was obtained from a point about 65° S. 112° E. at 4.30 a.m. ship's time on 8 March 1947 (22.00 G.M.T. 7th). This was in clear, still weather of the type which makes distant objects appear abnormally close. The sky above however was overcast by

veils of high cloud which seemed to threaten snow later. Several mountain massifs were seen along the horizon on bearings ranging from 140° to well past 200° from the ship. Those at the western end of our view may have been seen by us on earlier days, but could not be recognized with certainty from this new angle of vision; those at the eastern end, from 112° E. eastwards, included some shapely, pointed peaks of apparently greater height. I am tempted to suggest heights of 5000 to 6000 feet for these peaks from the appearance of the cloud development which followed, and to place them not much more than 30 miles, perhaps as little as 25 miles, south and south-south-east of the ship. Unfortunately before I could record this view in a sketch a light north-easterly breeze—very unusual in our experience in these longitudes—began to blow

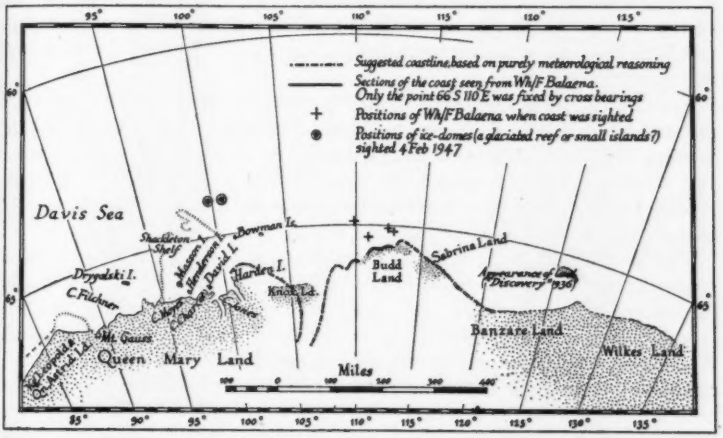

Suggested coastline based on purely meteorological reasoning
Sections of the coast seen from Wh/F Balaena. Only the point 66 S 110 E was fixed by cross bearings
Positions of Wh/F Balaena when coast was sighted
Positions of ice-domes (a glaciated reef or small islands?) sighted 4 Feb 1947
Davis Sea
Shackleton Shelf
Bowman Is.
Budd Land
Sabrina Land
Appearance of land (Discovery 1936)
Harding I.
Knox Lds.
Dovydoski I.
C. Filchner
Mt. Gauss
Queen Mary Land
Banzare Land
Wilkes Land
Miles

Fig. 1. Sector of supposed antarctic coastline based on Admiralty chart and observations from Balaena

towards the coast. As the air was near the saturation point (97 per cent. relative humidity observed at the ship) the coastal mountains almost at once became shrouded in stratus cloud which promptly formed all over their windward slopes. It was fascinating to notice that in the absence of any low cloud over the open sea, the presence of the hidden mountain ranges was still revealed by three or four deep banks of cloud below the main overcast. These were grey in colour and set around the southern horizon in odd orientations, only to be explained in terms of the alignments of the mountain ranges muffled in this purely orographic cloud.

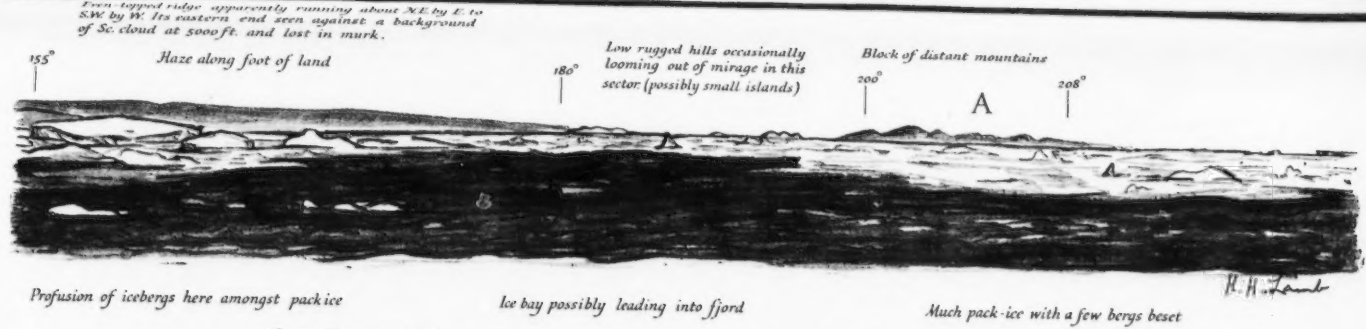
The cloud, which first formed as stratus on the mountain sides before our eyes, later developed cumulus and cumulonimbus forms. At the same time the upper cloudsheets grew in density and vertical development, finally producing the only really thundery sky which we saw in antarctic waters. No thunder was heard, but a hail shower fell at 9.30 a.m. (03.00 G.M.T. 8 March).

Meteorological work and conclusions

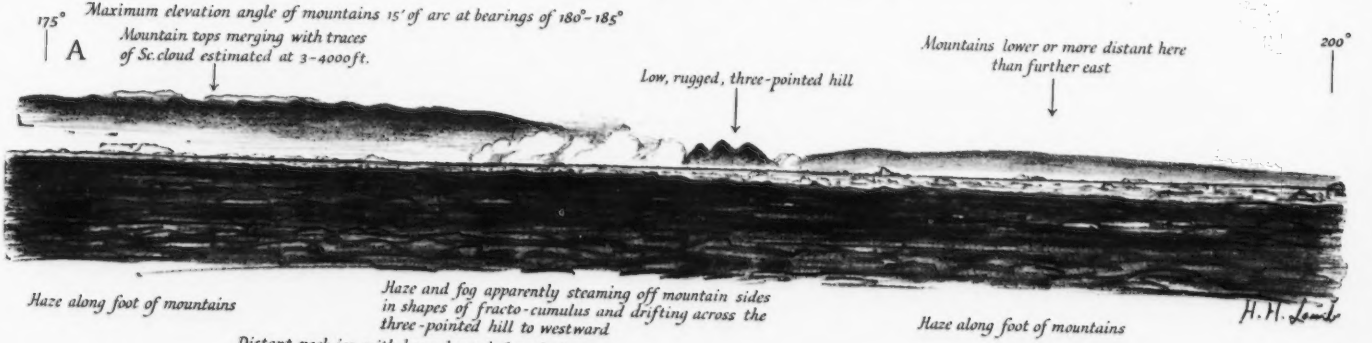
The Meteorological Office had agreed to send a member of the staff on this expedition in the belief that the experience would bring to light new facts of interest to meteorology. Perhaps it was a good thing that a hurried departure from England, and much difficulty with setting up the instrumental gear and preparing the basic arrangements for my work in the Antarctic during the passage south, gave me little time for any theoretical reading beforehand so that I was thrust into the task with a mind quite free from preconceived ideas. I trusted that the general principles of meteorology and some years' experience of the weather problems of the North Atlantic air routes and the Iceland–Norway region would serve me when applied to the problems of the Far South—and they did serve abundantly well, I think. The fulness of the analogy which this implies between the weather processes in middle and high latitudes of the northern hemisphere and of the southern is in itself an important conclusion.

Forecasting was begun on an explicitly experimental basis, and three disinterested people—John Grierson, flight commander, Commander Buckle, whaling inspector, and Alec Bryce, photographer for the Rank Organization—very kindly gave time to keep a check on the results of the weather forecasts so that I could judge their accuracy by results and test the value of various changes of procedure made during the season.

The basic technique of weather forecasting is to prepare from day to day a consistent and unbroken sequence of weather maps, showing the developing patterns of air currents and the zones of conflict (called fronts) at their boundaries. The likelihood of this proving feasible over the broad expanses of the Southern Ocean, almost unvisited by shipping and containing few islands on which there are folk to radio reports of the weather observed, was dubious from the first. On top of this came a severe blow when it was discovered that, owing to the highly competitive nature of the whaling industry, the other whaling ships operating in various sectors of the Southern Ocean had no intention of sending out the weather reports we had been promised. This situation was to some extent saved by the generosity of Mr. Trouton, chairman of United Whalers, who provided a special radio set and a whole-time radio operator to pick up meteorological messages from wherever they could be received. The keenness of the operator, Mr. Robert Currie of Watford, secured a good coverage of observation reports from places scattered widely over an area which included all the southern continents and the islands in the South Atlantic, as well as Madagascar, Mauritius, Tasmania, and New Zealand; but the only other reports of observations in high latitudes besides our own were from the Falkland Islands and their dependencies in the Far South. Unfortunately we were around the other side of the world, nearly 180° of longitude east of these permanent stations in the Falkland Islands Dependencies, whose importance may be judged from the fact that their reception without any prolonged interruption due to poor radio conditions was found to be vital even in the Australian sector. We had cause to be grateful to the naval station at Simonstown for arranging a relay service to ensure that we got these messages without so many breaks as would have imposed interruptions on the forecasting service. Interruptions did occur, but only


Even-topped ridge apparently running about NE by E to SW by W. Its eastern end seen against a background of Sc. cloud at 5000 ft. and lost in murk.
155°
Haze along foot of land
180°
Low rugged hills occasionally looming out of mirage in this sector (possibly small islands)
200°
Block of distant mountains
208°
A
B
Profusion of icebergs here amongst pack ice
Ice bay possibly leading into fjord
Much pack-ice with a few bergs beset
H. H. Lamb

Coast Ranges of Antarctica *as seen from Wh/F. Balaena 65°78′S. 111°00′E. at 1200 G.M.T. 22.2.47*
Sketch at 30-50 miles from coast in extreme visibility


175°
Maximum elevation angle of mountains 15′ of arc at bearings of 180°-185°
A
Mountain tops merging with traces of Sc. cloud estimated at 3-4000 ft.
Low, rugged, three-pointed hill
Mountains lower or more distant here than further east
200°
Haze along foot of mountains
Haze and fog apparently steaming off mountain sides in shapes of fracto-cumulus and drifting across the three-pointed hill to westward
Distant pack ice with bergs beset before the land
Haze along foot of mountains
H. H. Lamb

Coast Ranges of Antarctica *as seen from Wh/F. Balaena 64° 56′S. 109° 57′E. at 0600 G.M.T. 22.2.47*
Seen at great distance in extreme visibility shortly after weather and sky cleared

on one or two very rare occasions of complete radio fade-out which denied us reports from anywhere.

That it was possible to maintain a consistent series of daily weather maps derived from observations at such widely separated points was a surprise to me. Experience showed however that it was always possible to relate the features of cloud structure and alignment observed from the ship to the weather maps and their circulation patterns, even when the nearest reporting stations were 1500 to 2000 miles away. Other tests became available in time, and towards the end of the season some unofficial reports of weather were even obtained from other whaling factories. The ability to draw weather maps indicated of course that the theoretical weather processes work with great regularity over the world's widest ocean. It also provided fresh verification of our fundamental theories and prompted the following general conclusions.

First, the lessons of meteorological experience and the accepted theories regarding weather processes in other parts of the world, notably the North Atlantic Ocean and Greenland–Iceland–Norwegian Sea region, worked well when applied to the Far South.

Secondly, one particular hypothesis, based on my own experience in the northern hemisphere, was probably new or had not been formulated before. It might be stated as follows: that the influence of a stable, warm anticyclone or system of high pressure is paramount during most of its life history over wide areas extending for thousands of miles from the centre; these high-pressure systems guide the main supplies of warm air towards higher latitudes, steer the storms around their peripheries, and so control the circulation patterns far beyond their own limits. Fortunately most of these high-pressure systems in the southern hemisphere are situated in tropical or subtropical latitudes, where the network of observing stations gives adequate day-to-day information about the shape of the anticyclone cores. Without this assumption of anticyclonic control I do not think I could have completed the weather map across the wide expanses of ocean in higher latitudes. (The truth of this hypothesis is implied in every test that has supported belief in the authentic character of the chart analyses, including in the first place the *Balaena* observations which showed the features to be expected from the steering towards us in appropriate situations of disturbances originating thousands of miles away near Madagascar and elsewhere.)

Thirdly, in many longitudes south of about 62° 30′ S. the *Balaena* weather observations registered effects which could be attributed to the topography of the unknown land some 200 miles or more farther south. This was a snag for forecasting at first; but orographic effects, as we call the effects of mountain ranges on winds and weather, are usually fairly regular. They were so here, and we soon learnt what to expect—a process that involved almost inevitable assumptions about the geographical features responsible.

Fourthly, as a logical consequence of these conclusions about the controlling influence of the subtropical anticyclones in each sector and the topographical influence of the antarctic land mass in the Far South, it appears that the climate of the Southern Ocean is by no means so uniform and devoid of characteristic regional differences in different longitudes as has often been supposed.

An experiment in forecasting: antarctic anticyclones

Before going on to consider the implications of the *Balaena* weather charts and of our observations in more detail, I want to say a little about the results of checking the charts in the light of later information.

Errors in the position and intensity of weather systems came to light here and there, as was to be expected, but in very few cases was there any radical difference affecting the character of the circulation pattern. Accuracy improved as the season went on *and as the charted area was extended.* This last discovery was contrary to expectation, for the extension of the charted area was forced upon me as *Balaena* went farther and farther east, getting always farther away from the other high-latitude observing stations in the Falklands sector. This must, I think, imply a significant tendency for developments in all longitudes around the southern hemisphere to be interrelated, so that one grasps them better by considering the entire hemisphere or a large portion of it.

As an experiment, from 19 to 27 March 1947 I extended the charted area right across the South Pole and joined it up across the South Pacific to cover the entire globe south of 70° S., whilst it still reached almost to the Equator in the Atlantic and Indian Ocean sectors. This was not such a big step forward from the area I was bound to consider by that time, when *Balaena* was operating south of Australia, for no matter how far east we went I could never dispense with the reports from the Falklands sector; nevertheless I felt there was an element of bravado about it at the time. However this series has proved to be about the most reliable in detail of the whole season, and indicated weather features which have since been verified in several widely separated sectors.

One very interesting feature of this map sequence is that it shows a surge of rising pressure moving across Antarctica along, or closely parallel to, the route described by Sir George Simpson [1] in his classical account of his work with Scott's last expedition. Between 19 and 23 March 1947 a pressure surge moved from east to west across Antarctica, starting from James W. Ellsworth Land; but instead of radiating from a point 80° S. 120° W. in Ellsworth Land, as suggested by Simpson, this surge seems to have come in from outside, originating in the breakdown of the subtropical high-pressure system of the south-west Pacific east of New Zealand. This view carries with it the further suggestion that warm air of subtropical origin was transferred, particularly in the levels of the atmosphere above about 4000 feet, far to the south and possibly right over Antarctica. No information exists to show what temperatures might be observed in this air upon its arrival over Antarctica or how rapidly it would be chilled thereafter by the radiation conditions of high latitudes; such invading warm air would in any case normally be separated by a shallow, surface layer of extremely cold air from the actual ice of the antarctic plateau, but it is likely that the more abrupt mountain peaks and ranges would penetrate it.

This pressure surge of 19 to 23 March 1947 followed a period in which there seems to have been no room between the surrounding low-pressure systems for an anticyclone over the antarctic continent. My daily weather maps of this

[1] G. C. Simpson, "Meteorology," vol. 1, pp. 186-96, in 'British Antarctic Expedition 1910–1913.' London and Calcutta, 1919–23.

season lead me to conclude that we should think of the south polar anticyclone not as a permanency but as a recurrent feature subject to most of the same laws of life and decay that apply to high-pressure systems everywhere.

There is one difference however: anticyclones seem never to become stabilized over the almost frictionless surface of the Southern Ocean. As this ocean entirely encircles the earth, warm anticyclones over it could never withstand the dislodging onslaught of colder, dense air currents constantly arriving from the west and south-west. In this way the south polar regions are isolated by the ocean from the great accumulations of warm air built up in the upper levels of the anticyclones of the tropics to an extent that the Arctic is not. Transfers of warm air towards the Antarctic such as I have described are nipped off long before such great masses of air have been transferred as sometimes reach the Arctic. Thus, although I believe that the process of formation of the south polar anticyclones is the same as that which forms, for instance, the Greenland and Iceland anticyclones of cold winters at home, the pressures are all much lower in the Antarctic. Perhaps the fact that great masses of air are commonly transferred from the tropics to the Arctic, and are sometimes virtually locked up there, whereas this cannot occur on the same scale in the Antarctic, is sufficient cause to explain the general low level of atmospheric pressure everywhere south of about 50° S. and the uneven distribution of the earth's atmosphere between the northern and southern hemispheres which that implies.

Weather observations: regional and topographical influences

Let us now return to consider the factory ship's observations south of 62° 30′ S. in the Indian Ocean and Australian sectors, where the coast of Antarctica is not more than 200 miles away and the regularity of certain features may be a reflection of more than transitory conditions.

One has to be very cautious in drawing any conclusions about permanent climatic features from the observations of a single, moving ship. I have had this difficulty in mind all along, and for this reason I propose to focus attention on the observations near the coast of Antarctica, where influences due to the relief of the land may reasonably be expected, and to take account only of effects noticeable in 75 per cent. or more of the observations in the area.

I should like to mention that I am indebted for help in this work, which had to be begun during the season for forecasting purposes, to Mr. Leslie Holmes of the *Balaena* air party who voluntarily devoted much time and interest to it.

Since our return to England it has been possible to use the log of another ship which operated in the same sector for checking and making comparisons. Table 1 gives the figures for mean wind force on the Beaufort scale (0 to 12) and the frequency of the commonest wind directions, using the records of both ships.

We may notice first that these figures show lighter winds over most longitudes between 70° and 115° E. in the Far South than appear to be typical of the belt of westerlies, where, for instance, Kerguelen Island is quoted as having a mean annual wind force of 5. On the other hand, the factory ship's experience agrees well with the mean of 3·5 from a year's observations of wind

force at the former "Gauss" expedition station near the coast in 90° E. and about 66° S. On the whole this is a sector which seems to be characterized by quiet weather with light winds; and relatively high pressure values are observed in extensions of the antarctic anticyclones which occasionally thrust out from the coast, especially between 90° and 105° E.

Table 1.—*Winds observed south of* 62° 30′ *S.*

Longitude limits (° E.)		115–110	110–105	105–100	100–95	95–90	90–85	85–80	80–75	75–70
Beaufort wind force (mean)		5·0	4·1	3·2	3·6	3·4	3·7	3·5	3·7	(5·5)
Prevailing wind directions by percentages of all observations	N.									
	N.E.					12	14	15		
	E.	24	21	**25**	24	**38**	**21**	**24**	**21**	12
	S.E.	**51**	**27**	**25**	**37**	26	16	12	18	**29**
	S.		14		19				10	18
	S.W.		21	19			12	12	*21*	24
	W.		12					12		12
	N.W.						16		10	
Number of observations		74	79	33	67	86	73	102	37	(17)

Only towards 115° E. do conditions show signs of becoming prevailingly stormy. The upward trend of mean wind force probably continues farther east; the whalers do not consider it worth while to go beyond 117° to 120° E. on account of storms, at any rate once the summer is past. There are reasons for thinking that a similar wind regime, with frequent south-easterly storms, exists off Enderby Land in 50° to 70° E. It seems probable that the fiercest easterly storms and southerly blizzards only occur near mountainous parts of the coast, in fjords and in valleys on land; that is to say, in places where the free flow of the wind is upset by convergence effects. The general atmospheric circulation probably also makes certain longitudes more liable to severe storms than others. On both counts the worst places for violent storms and blizzards are probably near the mountainous west shores of the Ross Sea and Weddell Sea. More occasional violent storms might occur near any mountainous section of the coast, and the stretches between 50° and 70° E. and east of about 110° E. are probably worse than elsewhere. It is an odd result of funnel effects near mountain ranges that to avoid the very fierce winds one should get far away to a much more open region. The contrast between Amundsen's experience at his base at Framheim on the Ross Barrier and the storms about Scott's base in McMurdo Sound illustrates this paradox of the more open locality being the more sheltered from blizzards.

In passing, I will mention that the weather charts suggest that the Brave West Winds of the Roaring Forties and Fifties may be habitually stronger between 45° and 55° S. in Australian longitudes (110° to 140° E.) than anywhere else except off Cape Horn.

The most striking feature about the wind directions in Table 1 is the great preponderance of south-easterly winds near the eastern limit (110° to 115° E.), where winds from the east and south-east together made up 75 per cent. of the observations over about nineteen days.

Moving west one notices a tendency to occasional south-westerly winds between 110° and 100° E., and pilot balloon ascents show that these winds

represent the densest and presumably coldest air stream of all, which undercuts the south-easterly winds from time to time. The lowest temperatures of our voyage were observed in these south-westerly winds (16° F. over open water even in mid-February) and in winds from various southerly directions in the Enderby Land sector (11° to 12° F.) at the end of the season. It is reasonable to suppose that these south-west winds near the coast in 100° to 110° E. are drawn from the far interior of the continent.

Northerly and north-easterly winds are almost absent from the observations east of 100° E. at least as far as 115° E.; and if a light breeze from this quarter did occur for an hour or two before an advancing storm, the freshening wind soon swung into the more usual east-south-easterly quarter.

West of 100° E. northerly and north-easterly winds become noticeable and were observed with increasing frequency as far as 80° E. These longitudes between 80° and 100° E. gave us higher air temperatures than elsewhere, and the indraughts of warmer air from the north were accompanied by a greater tendency to fog and mists of light snow and drizzle.

As one approaches longitudes where the coast lies appreciably farther south (west of 82° to 84° E.), one notices more variability of wind direction south of 62° 30′ S.

Strong southerly winds were remarkable for their absence over most of the Indian Ocean sector, even in situations which might have been expected to produce them. Still more surprisingly, winds from due south were hardly observed at all in longitudes 100° to 105° E. and 110° to 115° E. where both south-easterly and south-westerly winds were prominent. This must, I think, be attributed to some topographical feature; and the fact that south winds made up 14 per cent. of the observations in the intervening strip between 105° and 110° E. conceivably indicates some wide mountain-girt inlet between 105° and 108° E. in the unseen sector of the coast.

Table 2 presents an analysis of the occurrences of cloudiness, clear skies, and poor visibility in our observations south of 62° 30′ S. The figures are much what one would expect from the wind regimes already discussed.

Table 2—Cloudiness, clear skies, and poor visibility south of 62° 30′ S.

Longitude limits (° E.)	115–110	110–105	105–100	100–95	95–90	90–85	85–80	80–75	75–70
Mean cloudiness in tenths of sky covered	9·4	7·4	9·4	8·6	9·2	9·2	9·0	8·7	(9·6)
Percentage of observations with less than one-quarter of sky covered	4	17	0	5	6	3	1	3	(0)
Percentage of observations with visibility less than 1 km. (*i.e.* fog)	4	0	0	3	0	5	6	0	(0)
Total number of observations	55	60	25	58	69	60	94	35	15

Out over the open ocean overcast skies are general. The constant supply of evaporated moisture from the sea surface is carried aloft and condensed again as clouds in the air layers between 2000 and 5000 feet. When a patch of clear sky does appear, its extent is generally so limited that it passes over any given point in three to five hours. Near the shores of the antarctic continent

however blue sky and sunshine become noticeably more frequent, particularly with southerly winds. Consequently we find clear sky figuring in the table most frequently in 105° to 110° E. which is at the eastern limit of the longitudes characterized by light winds with predominant southerly, offshore wind components. The actual minimum of cloudiness was between 105° and 107° 30′ E., with 6·9 tenths and 24 per cent. of the observations giving less than one-quarter of the sky covered. This narrow strip, perhaps extending from 104° to 108° E., has low temperatures in the frequent offshore winds but probably has one of the brightest climates to be found anywhere around Antarctica. The mean cloudiness at the coast itself may be 5 tenths or less; and the winds would not be strong unless there is some narrow valley to cause a funnelling effect.

East of about 108° E. the increasingly stormy conditions were accompanied by skies frequently overcast with cloud at rather high levels. In the same longitudes the observed occurrences of bad visibility were all due to snow.

West of 104° E. we encountered a belt of overcast conditions and some snow, the cloud systems showing a continual south-west to north-east alignment and apparently marking the zone of conflict between the very cold airstream sweeping off Antarctica east of the line and the warmer air masses of the Indian Ocean circulating on the west side. The change of temperature on steaming through this belt was sharp, reaching 10° F. or more.

Between 80° and 100° E. the relatively frequent fogs included some that were widespread, such as we did not experience elsewhere south of 62° 30′ S.; and this is certainly connected with incursions hereabouts of warmer air from the north. Such fogs are probably both more widespread and more frequent at points farther north. Most of the fogs we observed were however frontal fogs, occurring in isolated, narrow belts only 5 to 25 miles wide, representing originally the boundaries between unlike airstreams. Sometimes these narrow fog-belts were very much twisted up in the circulation pattern and drifted slowly hither and thither for days at a time, so that their onset was not confined to winds with a northerly component as was practically true of the more widespread fogs.

Possible major topographical barrier in east Antarctica

So far we have discussed the noticeable guiding of the winds, perhaps by coastal mountains not more than 3000 to 5000 feet high in most cases. The apparent absence of any strong southerly winds in the rear of storm centres over much of the Indian Ocean sector seemed however to point to a more pronounced topographical barrier: the wind was not diverted into another direction, it just fell light.

Later in the season it became apparent that wind currents and even frontal boundaries, giving extensive cloudsheets at least in the upper levels as well as much lower cloud and light snow, were regularly swept around the rear of the depressions in the Ross Sea–Wilkes Land sector,[1] right over the ice-cap and later came offshore, travelling northwards over the Wilkes Land coast; they

[1] There is not enough evidence to decide how many of these depressions had ever reached as far east as the Ross Sea. Some at least seem to have mounted the Wilkes Land coast east of 120° E. and pursued recurving tracks over that territory.

seemed never to get farther west over the plateau than a line running north-eastwards from about 80° S. 80° E. towards the coast in 100° to 102° E. The cloudsheets and frontal snowbelts were observed moving out to sea; and the observed features of prevailing wind directions near the coast both east and west of 100° E. would also fit the existence of a major barrier along this line, which marked a change of regime and which, if continued beyond 80° S. 80° E., would bisect the territory of east Antarctica between the west coast of the Ross Sea and the Atlantic seaboard.

The cold south-westerly winds of 104° to 108° E. seem to signify some such barrier; and so do the position and alignment of the observed zone of conflict offshore where these winds encounter the warm air circulating south from the Indian Ocean.

Ultimately the whole trend of recurving depression-tracks, both from the Ross Sea–Wilkes Land sector and in the Indian Ocean sector on the other side of this line, lend support to the belief in a topographical barrier in the interior of the continent of similar order of magnitude to the Alps or Rocky Mountains, say 12,000 to 15,000 feet in height. There is no evidence to suggest how far the barrier may extend west and south-west beyond 80° S. 80° E., nor whether it may be a great range of mountains or the main crest of the antarctic ice-cap. Nor can one say whether its crest presents an unbroken contour or is interrupted; but I think its north-eastern ends is likely to be nearer 70° S. and 97° to 100° E. than at the coast itself.

It will be interesting to see if this postulated geographical feature, which might be looked upon as the backbone of Antarctica, is ever confirmed by the eye of an explorer.

We may note here that the principal south polar anticyclones tend to take up positions centred over east Antarctica near the line of this supposed summit and show signs of dividing across it when they decay. It also seemed to me that very occasionally a depression moved right across the ice-cap on one side or other of the line of this supposed barrier, but probably never crossed it.

Oceanographical and other observations

Finally I have time to refer briefly to one or two other points of interest.

Ocean surface currents.—There are not many opportunities for making deductions about water drift while navigating a whaling factory on the whaling grounds, on account of the many erratic changes of course when picking up whales; but we were able to work out one or two. I have compared these with other information from the logs of vessels that have sailed in the Southern Ocean, available in the Marine Division of the Meteorological Office, and I am struck by the fact that the general pattern of water drifts seems to be more nearly parallel to the pattern of prevailing winds than it would be if the winds were the driving force and the left-hand deflection caused by the rotation of the earth were allowed for. Can it be that the water, not only in all its great depth but even at the surface, moves in an ocean-wide system of convection [1] in response to the thermal stresses in it, which must have a geographical

[1] The word "convection" is used here not in its meteorological sense but in the broader sense common in physics.

distribution very similar to the normal arrangement of warm and cold sources in the atmosphere?

We had other evidence which might be taken to suggest that the movement of the surface water really does follow similar laws to the surface winds and independently produces similar patterns.

In the first place, warmer surface water as well as milder air was found

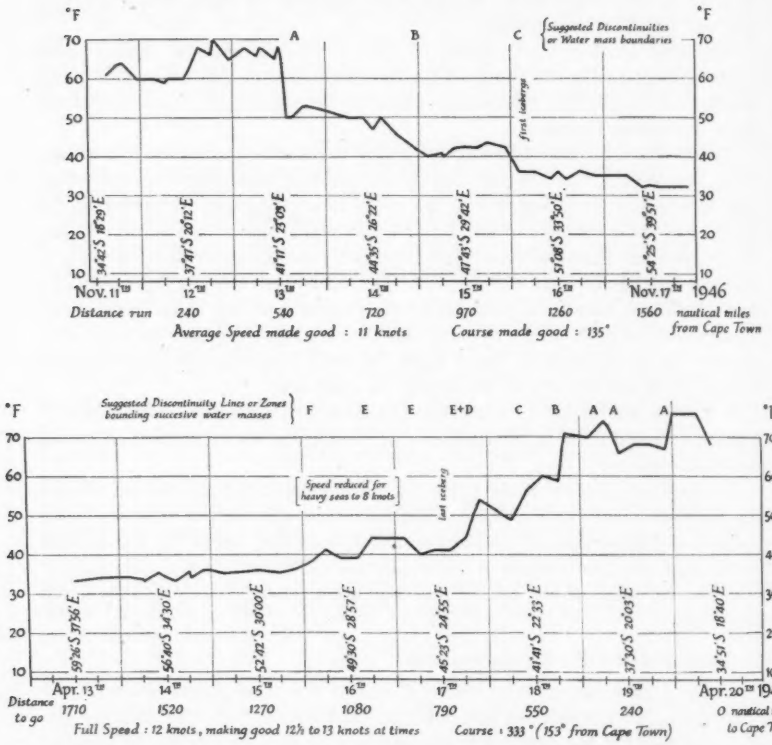


Fig. 2. Sea temperatures recorded while crossing Southern Ocean

between 80° and 100° E. than elsewhere in high latitudes, and presumably enters from the north.

Secondly, on our outward and homeward voyages, instead of two sharp changes of water temperature corresponding to the Subtropical and Antarctic Convergences, we observed respectively three fairly sharp changes on the way south and six minor changes well spaced out across the whole width of the ocean on the way north (Fig. 2). Can it be that the water-surface temperature-discontinuities range over the whole width of the ocean, varying in sharpness and even in number like the fronts in the air circulation in different situations? And do they continually get twisted up and lost in the complexity of the

circulation, and continually reappear at the recognized convergence lines which have been called the Subtropical and Antarctic Convergences?

Ice.—Between March 3 and April 12 we travelled rather quickly west along the edge of the pack ice. This gave an opportunity for an approximately instantaneous survey of the ice edge at, or just after, the end of the warm season. The main features were: no ice off the coast of Antarctica at all in 116° E. (reported by our whaleboats), with the ice edge also very far south and certainly south of 64° S. in the other stormy sector between 50° and 70° E. off Enderby Land; by contrast there was congested pack-ice reaching north in a great nose or ice headland at 101° to 102° E. as far as 62° 30′ S. This is 100 to 150 miles north of Bowman Island and the archipelago where on our outward voyage we noted a considerable space of ice-free water between an ice blockage at 64° S. and at least 63° 30′ S. The extensive ice found just north of here at the end of the season probably means that this is the limit reached by ice swept from the Australian sector by the south-easterly storms farther east, and where it runs into a region of slack water and variable winds. In this too we seem to have evidence of an important frontier in both the wind and water circulations about this longitude.

Icebergs were most numerous near the Banzare Bank, where a depth of about 90 fathoms is charted near 59° S. 77° E., and near the Gribb Bank about 52° S. 88° E. The whalers believe that bergs commonly go aground on both these banks.

Ocean swell.—We had the chance to make some interesting observations of swell, although for two-thirds of the weather observations south of 50° S. there was only a slight swell or none at all.

During the periods of storm the highest waves observed in the great swells were 30 to 40 feet high. The wave length seldom exceeded 600 feet.

The swell appears to run on in the direction of the wind that has caused it, and consequently north-westerly swells produced by storms in the Fifties often reach the ice. At the ice edge and near the southern limit of the open water, such a north-westerly swell is liable to be followed by an easterly storm if the wind is felt at all; sometimes the storm simply passes far out over the ocean to the north and conditions near the ice remain quiet and fair apart from the swell.

We also found evidence that at the flank of a great swell, where the disturbed water abuts upon either a coastline or a belt of pack ice or even upon the great mass of inert and undisturbed water outside the storm, the waves are deflected until their crests are ultimately in line with the direction of the fast-moving windstream which has produced them. At the same time the distance between the crests shortens and the waves increase in height, so that a shorter and steeper swell is experienced at the flank of the storm. On the other hand, the billows which make their way in amongst the pack ice are quickly deflected through 60° to 90° if the storm is blowing parallel to the ice edge, and they are gradually damped down. The smaller ripples soon disappear on encountering the first ice; and the great, smooth swells near the ice edge, running through the lagoons amid the ice, are a strange sight.

The biggest swells occur where the fetch of the wind is longest, and are shortened and steepened if they run head on against the ice. Northerly and

north-westerly swells satisfy this condition over most of the Indian Ocean sector; so that although northerly gales are probably not amongst the strongest storms in these waters they produce the ugliest seas outside the ice.

DISCUSSION

Before the paper the CHAIRMAN (Mr. J. M. WORDIE) said: Our speaker, Mr. H. H. Lamb, has been for many years a member of the staff of the Meteorological Office, and his main interest there has been long-distance air-route forecasting, particularly for the North Atlantic. He was selected to accompany the *Balaena*, the great whale factory-ship, in the 1946–47 season in order to help in planning the flights of the air party on board under Mr. John Grierson. As a result of his work on that expedition Mr. Lamb has come back with most useful and stimulating information.

Mr. Lamb then read the paper printed above, and a discussion followed.

Sir GEORGE SIMPSON: As a pupil of Professor Horace Lamb, it has given me very great pleasure to be able to listen to his grandson giving this interesting account of work which he himself has done in the Antarctic. Except for the voyages of Cook in 1775 and Bellingshausen in 1822, all the information available about the Antarctic before Queen Victoria came to the throne was derived from whaling and seal-fishing expeditions, mainly by American and British sailors. Those familiar with the Antarctic map will recall Enderby Land, the Weddell Sea, and the Balleny Islands, all names which came from either captains or owners of whaling ships. It is therefore very gratifying to see that whalers are again being used for scientific purposes in the Antarctic.

It is now thirty-five years since I was in the Antarctic. I have been much interested to see the tremendous differences in the way of approaching the Antarctic since I was there. When I went to the Antarctic nobody would have thought for one moment of taking an iron ship across the Antarctic Circle, but now about one hundred iron ships cross the Antarctic Circle every summer. Again, while we had a steam-engine to our ship it was only an auxiliary one. The chief way of getting about then was by sails, but now, I believe I am right in saying, there is not a single stitch of canvas amongst the whole of the *Balaena* whaling fleet. As to radio, Captain Scott's expedition was, I believe, the last to go to the Antarctic without wireless, so that we were cut off from the rest of the world from the moment the *Terra Nova* left New Zealand until she came back to pick us up about fifteen months later. To-day members of such an expedition are in touch with the rest of the world the whole time. Mr. Lamb was able to obtain meteorological information from practically all parts, certainly all inhabited parts, of the southern hemisphere.

But the changes in material things are no more remarkable than the changes in scientific work in the Antarctic. There is no doubt whatever that the changes in meteorology have been tremendous. When we were in the Antarctic thirty-five years ago we knew nothing whatever about what is now called "the structure of the atmosphere"; a modern synoptic chart to us would have been meaningless. We had never heard about "warm fronts," "cold fronts," or "occlusions," and Shaw had not even devised the "tephigram." Those are all tools of the modern forecaster.

Mr. Lamb described how he was able to form some idea of the character of the coast from the observations which were taken from the ship while some distance to sea. I was much interested in that work because the method used was certainly very ingenious: but I want to sound one word of caution. Mr. Lamb

was only in the Antarctic for one summer season. The variations in weather from year to year in any one part of the Antarctic are tremendous. Also he only had observations from two ships over a long stretch of coast, and therefore his observations were very few. He has said so in his paper, and therefore he agrees with what I say to that extent. I feel that the number of observations is far too small to generalize on; yet it was right to make the attempt so that future observers can give attention to the particular points to which Mr. Lamb has called attention.

In conclusion, I should like to congratulate Mr. Lamb, and also the Meteorological Office who sent him, for a piece of really valuable scientific work.

Mr. GORDON MANLEY: I should like first to express thanks on behalf of the Fellows of the Royal Meteorological Society present for an invitation which we greatly esteem.

I think we should express appreciation of the fact that the Meteorological Office was able to provide Mr. Lamb's expert assistance for this expedition, with the result that we have had this most stimulating paper, full of ideas for future work.

I should like to say how much as a geographer I have admired the boldness with which Mr. Lamb has provided a synoptic interpretation of the meteorology of a large part of the southern hemisphere. If Mr. Lamb's conclusions are borne out they may help in the interpretation of the movement from time to time of northern hemisphere Highs from the Azores *via* Scandinavia to Greenland, such as we saw in February 1947. I thought I recognized something of the sort in analysing Professor Wager's Greenland results in 1936, but presumably any such movements will be much more complicated in the North and hence should be studied in the South first. I hope that Mr. Lamb will have opportunity to coordinate some of the earlier results; for example, those of Byrd and Mawson in 1929 and 1939. It should be possible to ascertain whether these support his findings about the movement of anticyclones in the Antarctic.

I should like to ask Mr. Lamb whether such movements are sufficiently regular, in his opinion, to provide an explanation of the puzzle to which Sir George Simpson drew attention thirty-five years ago; namely, the pressure waves of the Antarctic, recently confirmed to a certain extent by Dr. Loewe. Perhaps Mr. Lamb will be able to go further in that direction.

I am fascinated by this meteorological approach to topographical features. After all, over forty years ago Meinardus as a meteorologist prognosticated the height of the antarctic continent. The existence of an ice-shed in the region Mr. Lamb requires is wholly compatible with the views of Herrmann, based on the findings of the German 1939 flights from the *Schwabenland* over the Norwegian sector. Herrmann thinks it likely that the ice-shed in about 80° S. along the meridian of Greenwich reaches 15,000 feet (*Q.J. Roy. Met. Soc.* 72 (1946) 309). It is not yet clear whether it can be supposed to continue as a clear-cut crest all the way towards Mr. Lamb's point on the coast, or whether there should be a saddle within that ice crest in the manner suggested by Professor Wager for Greenland some years ago, well before it was confirmed by the American flights.

There is another point arising from Mr. Lamb's paper. We have all heard of the remarkable evidence of ice retreat at high levels and in particular the small frozen lakes at 6000 feet or so. Professor Ahlmann thinks they testify to a post-glacial climatic amelioration beyond anything that exists at present. The lakes are only 200–300 metres long. Can they have been produced by occasional rain? They are obviously very shallow; some are detached from ice, and presumably the terrain is irregular after the disappearances of the ice. I should like to know Mr. Lamb's opinion regarding the possible import at high levels of

sufficient maritime air to provide rain in 71° S. at 6000 feet. After all, Belknap had rain at 8800 feet on the Greenland ice in 75° N. and it does not seem to me mechanically impossible that there should be something in the nature of occasional rain on that high borderland of the antarctic continent, if Mr. Lamb's theories are established.

I will conclude by saying that I hope the bold venture in interpretation that Mr. Lamb has given us will prove justified and that it is as stimulating to others as it has been to me.

Professor A. AUSTIN MILLER: I had the privilege of reading the paper in manuscript, and many interesting points occurred to me, most of which have been raised already. I wish to add my congratulations to those which have already been voiced, and to express my surprise at the remarkable degree of success achieved in forecasting, in view of the remote and scattered pattern of reporting stations and the little-known nature of the topography of adjacent land. In the absence of those essentials of weather forecasting, it is remarkable that Mr. Lamb has been able to forecast at all.

We geographers are sometimes inclined to accuse the meteorologist of neglecting the topographical factor. To the best of my knowledge, this is the first time that the influence of topography has been applied, as it were, in reverse, and that the topography has been forecast from the weather by the faint "echoes" reflected from distant, undiscovered mountains. It reminds one strongly of the geophysical methods used by oil geologists, whereby inaccessible structures and ore-bodies are detected as a result of their effects at the surface. Some day these mountains will be discovered if they exist, and then Mr. Lamb will enjoy the thrill that Boyd-Dawkins must have felt when borings revealed the presence of the East Kent coalfield whose presence beneath 2000 feet of cretaceous rocks he had forecast.

May I ask for a little more information about the strong, cold, south-west winds experienced, I understand, on about twenty occasions between 100° and 110° E. off Knox Land? What are their other characteristics and what sort of air mass do they represent? They imply a Low to the south-east. Are they in the nature of cold fronts following a low-pressure trough such as the fronts directed from south-west to north-east described later in the paper? I ask because in view of the very small number of observations that could be taken as the ship was passing it is not clear whether these are the prevailing geographical or semi-permanent features, or whether they just happened to be passing over at the time.

Dr. G. E. R. DEACON: I congratulate Mr. Lamb on his attempt to study antarctic meteorology by making a synoptic chart of the whole southern hemisphere; it seems to me that this is the way in which antarctic meteorology can most likely be forwarded. When the Discovery Committee were concerned with the detailed oceanography of a small part of the Southern Ocean there were many difficulties, but when the work was extended all round the continent the nature of the water circulation unfolded itself. The water circulation is something like that which Mr. Lamb surmises, and density currents really seem to exist. His two profiles across the ocean do not give good representations of the Antarctic and Subtropical Convergences, and generally one finds better indications of them. The convergences are usually plainer in other sectors than in the one south of the Indian Ocean, but one finds them there too.

I understood from Mr. Lamb's remarks that he found stronger winds south of Australia, and I believe someone has associated the mean wind strength with the temperature gradient; the temperature gradient from north to south is stronger south of Australia than anywhere else, and this may explain the difference.

The idea of basing a study of the weather in the Indian Ocean sector on observations made in the Atlantic sector, 180° of longitude distant, is amazing. One looks on the Roaring Forties as a part of the ocean traversed by depression after depression, and one would have expected to see a chain of half a dozen over such a distance. If there were only two it would be difficult to decide what is happening in advance of the first from measurements in the rear of the second. I hope that more details will be published.

With reference to the effect of the wind on the surface water, the conclusion that the water goes to the right of the wind in the northern hemisphere and to the left in the southern hemisphere is a mathematical result based on certain simplifying assumptions, but it seems to hold reasonably well in middle latitudes; it was also based on an observation made by Nansen in the *Fram* that the arctic ice moved to the right of the wind. If the water is sharply layered the movement might be nearer to the direction of the wind, but good evidence would be needed before questioning the general principle.

Mr. H. H. LAMB: I would like to thank those who have taken part in the discussion of my paper, particularly Sir George Simpson and all those others who have raised points of interest. I have brought along some samples of my *Balaena* weather charts, and if anybody is specially interested they are here to be seen.

I believe our summer season in the Antarctic was unusually fine; and some of the conditions which we enjoyed were unheard of in the days when Sir George Simpson was in the Ross Sea with Scott thirty-five years ago. In particular, radio made an enormous difference to us. Not only did it make my work possible but it also meant that there were broadcast programmes from Los Angeles and elsewhere to keep our spirits up.

I want to say that I have been aware all through of the danger of trying to draw conclusions about permanent features, whether climatic or about the nature of the land itself, from a few isolated observations made on a moving ship. What I must emphasize is that I had to do that: I could not have forecast the weather otherwise. It was a question of not knowing what the neighbouring land was like although it was within fifty, and sometimes possibly twenty-five miles of us. The assumptions I made were reasoned from the only material available: the weather observations—not only our own but also those of any other ships available to me at different times—and the general implications of my daily weather maps. I did not make more assumptions than I had to. And it seems to me that those assumptions worked well.

It seems too that the discoveries of the German *Schwabenland* expedition of 1939 lend some support. In the Norwegian sector, in 80° S. near the Greenwich meridian, they found the ice-cap to reach 15,000 feet: this might mark the continuation of the great topographical barrier in east Antarctica which I postulated. If the line of the barrier were extended it would reach that area. The question is, does it? I can only say that for my meteorological purposes it was a satisfactory working assumption.

Mr. Manley asked me questions about the warm anticyclones and their behaviour. That is a subject I had done some preliminary work on in the northern hemisphere before I went south. All I can say now is that the same hypotheses seem to work equally well in both the northern and southern hemispheres. To say more would be to enter upon a rather too complicated subject; but I hope to produce more evidence in due course.

The pressure waves, described originally by Sir George Simpson on very much less observational material than I had, seem to be substantiated by my weather charts. And I think my charting work offers the prospect of a reconciliation of this special concept of Sir George's regarding atmospheric processes in

the Far South and our normal ideas of the atmospheric circulations of Highs and Lows, airstreams and frontal boundaries. Other workers, notably Palmer and Ramage in New Zealand, have followed the fronts of the Southern Ocean as far south as 65° S., and I believe Admiral Byrd's recent expedition has mapped some of the air mass frontal boundaries in the Ross Sea area to nearer 85° S. That is in agreement with my charts. On the other hand, it has been suggested both by Simpson and by Loewe long afterwards that the pressure surges which cross Antarctica reach out to the north as far as Kerguelen Island in 50° S. and other islands in the Southern Ocean. It seems therefore that the familiar effects of fronts and depressions, which we know here at home, can be traced in high southern latitudes; and that the antarctic pressure surges can be followed from the Antarctic out into moderate latitudes. My charts suggest that these apparently conflicting influences can be seen as interlocking parts of the same atmospheric circulation.

Mr. Manley asked me about the possible cause of the high-level lakes which have been found in Antarctica. I believe these lakes are now frozen but have at some date been unfrozen, and that they are found between 5000 and 6000 feet up in parts of Antarctica. I see no reason to rule out the possibility that in extreme or abnormal circumstances rain might fall. I imagine that supercooled rain or drizzle is comparatively frequent, but this would of course freeze immediately on impact with the rocks.

Indications about temperatures existing in the free air over the south polar regions this last southern summer season are only available from very scattered points, including a few of Admiral Byrd's results and the observations of upper air temperature made by the Dutch whaling factory-ship in the South Atlantic sector not very far from the coast of Antarctica. I would like to add that we ourselves were not entirely without upper air information, inasmuch as I was able to send up balloons to check the upper winds ninety times during the 150 days we were in southern waters; also our aircraft took temperatures up to 10,000 feet on some occasions. All I can say about this question is that there is a good deal of evidence that warm air masses do exist at levels above 3000 feet, particularly in fine weather, but that the temperatures in them are in most cases a few degrees below the freezing point even in the warm season. I think it possible that in extreme cases one gets temperatures at or just above the freezing point in these warm air masses aloft.

As to the question about the south-westerly winds which we experienced in the strip between about 102° and 110° E.—not predominantly strong though on occasions rather strong—these winds were also experienced by other ships which crossed these longitudes during the same summer season. Some of these observations which we received were unofficial, which meant that there was no certainty about the precise position of the ship; but in general terms they agreed with our experience. The characteristics of most of these south-westerly airstreams of which I have observations were moderate south-westerly winds with fine weather, clear skies, and very low temperatures—the coldest air we experienced. I assumed that they came from the far interior of the continent. There were a couple of instances in which these winds freshened as front and frontal cloud systems advanced from the south-east towards us off the land. The front passed over our ship on at least one occasion, with a rise of temperature, being evidently a warm-type front—I assume, a warm occlusion. The south-westerly wind which had preceded the front was the coldest airstream we experienced. The south-easterlies, which we had more frequently in that sector, were less cold.

The CHAIRMAN: All the speakers have commented on Mr. Lamb's boldness, and I feel sure you will join me in appreciation of the clarity with which he has spoken and of the convincing way in which he has put forward his views.

THE LOW ISLES OF THE GREAT BARRIER REEF: A NEW ANALYSIS

RHODES W. FAIRBRIDGE AND CURT TEICHERT

INTRODUCTION

ON THE MORNING of Trinity Sunday, 10 June 1770, Captain Cook in H.M.S. *Endeavour*, on his voyage of exploration in the waters of eastern Australia, sighted what he described as a "small low island which lay about 2 leagues from the Main." This we know now as Low Isles. It consists to-day of two "isles" resting on a reef platform about 1 mile long, shaped like a horse's hoof pointing to the south-east and surrounded by a fringe of living coral. One of the isles is a small, oval-shaped, vegetated sand-cay with a light-house station; the other a mangrove swamp, most of which is permanently awash, but which nevertheless gives from afar the impression of being an island. According to local usage, only the sand-cay is called "Low Isle" while the mangrove isle is referred to as "Woody Isle," a distinction which is not recognized on Admiralty Charts or in the Pilot Book, and leads to confusion with the "Low Woody Isle" north of Cooktown; this usage is consequently ignored in scientific papers.

No part of the Great Barrier Reef area of Australia has been examined more thoroughly than Low Isles. It was here in 1928–29 that the British Great Barrier Reef Expedition under Yonge spent over twelve months of intensive study. In addition to many important biological examinations, valuable geographical data were recorded; among other surveys, a detailed plane-table survey was made, the resulting map[1] being on a scale of 1:5000, with spot elevations based on Admiralty Datum.[2] The map is contoured at 1-foot intervals for certain depressed areas in the "Mangrove Park" apparently below the reef-flat level (that is, about 4 feet above datum here), and at 4-foot intervals above datum on the sides of the cay; otherwise there are no contours. Careful soundings were made off-shore to supplement the Admiralty soundings of the main channel. Finally the Royal Australian Air Force, in September 1928, made a vertical photographic coverage of the Isles at a scale of 1 : 2400.

In 1945 the R.A.A.F. photographed the Isles again at a scale of 1:3000. The quality of both coverages is good, and with the very similar scales a close comparison is possible, permitting us to make an analysis of the isles' history over seventeen years, an opportunity which is believed to be unique in the study of coral islands. This analysis was supplemented by personal observations from the air and on the ground and forms the subject of this paper.

Classification of low wooded islands

Scattered at intervals along the so-called "Steamer Channel," [3] from near Cairns to the Cape York Peninsula, there are over two dozen rather similar

[1] *Geogr. J.* 76 (1930) facing p. 272.

[2] Based on mean lower low springs, determined by H.M.S. *Penguin* in 1905.

[3] This expression is current, colloquially, to indicate the surveyed channel running coastwise up the inner side of the Great Barrier Reef lagoon between the mainland and the central platform reefs. It is used freely by Steers and Spender.

small, oval-shaped reef platforms, each carrying one or more "isles" of sand-cay or mangrove type and bounded by a rampart or series of ramparts of coral material. Spender [1] has called these "island-reefs," while Steers [2] prefers to call them "low wooded islands." For the present study we may combine the two thus: a "low wooded island-reef." Low Isles may be taken as the "type" example (Plate 1, and map facing p. 74).

Steers [3] has described and illustrated the "ideal" example of one of these islands. It consists of a "reef platform," in shape a horse's hoof,[4] a crescentic or oval, flat-topped reef, convex to the south-east (the prevailing wind), on which repose a "sand-cay" at the north-west end and a "mangrove islet" at the south-east end. Practically surrounding the whole reef platform is a *fringe of living coral*, bounded towards the interior by one or more beach ridges of coral shingle, conglomerate or breccia, called "ramparts" by members of the British Expedition. The ramparts are gently sloping to the exterior but steep to the interior. In plan they show peculiar high spits, or rather tongues, and even long horns in the south-west and north-east of the reef platform. Where the older ramparts are eroded they exhibit a dipping stratification, most impressive from the air, and sometimes, as we noticed, most convolute, following presumably the lines of former shingle tongues. Steers [5] referred to them as "basset edges." This erosion plane or eroded platform is usually 3 to 5 feet above datum. Steers seems inclined to correlate it with the lower marine bench level, so widely recognized around eastern Australian coasts.[6]

Precisely analogous island-reefs are difficult to find in other coral areas, but those of the East Indies, and particularly those of the western end of the Java Sea and in the Bay of Batavia, make very instructive comparison.[7] Similar encroachments of shingle ramparts were noted by Verwey.[8]

Position and elevation

Low Isles are situated at 16° 23′ S., 145° 34′ E., some 8 nautical miles south-east of the mouth of the Daintree river off the coast of Queensland. They are 35 miles north-north-east of Cairns, a useful base with road, rail, airfield, and flying-boat facilities, and 8 miles north-east of Port Douglas which is

[1] *Geogr. J.* 76 (1930) 195.

[2] *Geogr. J.* 74 (1929) 250.

[3] *Geogr. J.* 74 (1929) 253; *Reps. Great Barrier Reef Expedition* (Brit. Mus. Nat. Hist.), 3 (1930) 12–15.

[4] The expression "horse's hoof" was the inspiration of Dr. F. W. Whitehouse, who showed this to be better fitted to our "solid" reef type than "horse-shoe," a term more suitable to open-ended atolls.

[5] *Geogr. J.* 74 (1929) 253.

[6] H. C. Richards and C. Hedley, *Reps. Great Barrier Reef Committee*, 1 (1925) 1–27; H. C. Richards, "Recent sea-level changes in eastern Australia," *Proc. Sixth Pac. Sci. Cong.* (1939) pp. 853–56; and others.

[7] J. H. F. Umbgrove, "De Koraalriffen in de Baai van Batavia," *Dienst v.d. Mijnbouw in Ned.-Indie: Wetens. Med.*, 1928, no. 7 (summary in English); "De Koraalriffen der Duizend-Eilanden (Java-zee), *ibid.*, 1929, no. 12 (summary in English); "The influence of the monsoons on the geomorphology of coral islands," *Proc. Fourth Pac. Sci. Congr.*, 2 (1929) 49–54; P. H. Kuenen, 'The Snellius Expedition,' vol. 5, pt. 2, "Geology of coral reefs," Utrecht, 1933.

[8] J. Verwey, "Geomorphological notes on the coral reefs of Batavia Bay," *Treubia*, Buitenzorg, 13 (1931) 199–215.

142°
145°
148°
Gulf of Papua
Port Moresby
Murray Is.
10°
Thursday Island
Cape York
1000 fms.
Cape York Peninsula
Zone of Semi-continuous Outer Barrier
CORAL
Osprey Reef
1000 fathom contour
Bewick I.
Houghton I.
Lizard I.
15°
Low Wooded I.
Two Isles
Three Isles
SEA
Cooktown
Dee (d) Reef
Cee (c) Reef
Daintree R.
Low Isles
Batt Reef
Port Douglas
Michaelmas Cay
Southern limit of "Low-Wooded" type of Island Reef
Cairns
Steamer Channel
Zone of Discontinuous Outer Barrier
Flinders Reefs
AUSTRALIA
The position of Low Isles in the Great Barrier Reef
Miles
60 0 60 120
Townsville
20°
Bowen
142°
145°
148°

connected with Cairns by road. The Outer Barrier is 20 miles east of Low Isles.

The floor of the Steamer Channel (and thus of the continental shelf) hereabouts slopes gently from the shore of the mainland to the edge of the zone of platform reefs where it rises sharply from a depth of over 20 fathoms. The gradient is almost exactly 1 fathom per nautical mile. Low Isles appear to rest on a slight but abrupt elevation from this otherwise rather even floor, a submarine ridge about 20 to 30 feet high and elongated north-north-west to south-south-east, parallel with the general trend of the granitic and metamorphosed palaeozoic series of the coastal ranges, all of which in this area demonstrate the most striking north-north-west, south-south-east orientation. This feature seems to be due partly to differential erosion of parallel folds and partly to parallel faulting.

Soundings off Low Isles indicate that there is a steady drop down to the south-west and north-east (that is, across this trend) to 10 and 13 fathoms respectively, in each case at only 400 feet from the shore. Along the axis to the south-east however the slope is quite gentle for the first 400 feet, after which there is a sudden drop, in places as steep as 41° or 1 : 1·1, reaching 14½ fathoms 700 feet from the shore. The foot of the slope here is somewhat depressed below the general level of the shelf-floor (see north–south section inset in map facing p. 74). To the north-west of the reef however the gradient is extremely gentle, falling away only 6 fathoms in 900 feet.[1]

The elevation of the reef platform at Low Isles is 2 to 4 feet above datum level, while pools in the "Mangrove Park" and narrow marginal areas known as "moats"[2] reach down to 1 to 2 feet above datum. The edge of the platform is bounded by "ramparts" of coral shingle or breccia which rise as high as 8 feet or more. The sand-cay itself rises to 16 feet above datum, that is, 11 feet above mean sea-level or only 6 feet above high springs. The mangrove swamp, on the other hand, is mostly at 2 to 4 feet above datum, though where its margin has been invaded by the coral debris of the ramparts it is higher. One tiny spot on the east side of the swamp, a few square yards on the so-called "Green Ant Island," is about 12 feet above datum but this is strictly speaking part of the rampart system.

Winds, currents, and tides

Low Isles lie in the belt of the South-East Trade winds and records over a twelve-month period, made during the British Expedition's stay,[3] showed 85 per cent. of the winds to be in the south-east quadrant. Only in the southern summer (December–February) is the influence of the North-West Monsoon felt at all, and then only spasmodically, the south-east influence generally predominating. In this season however there is an extremely

[1] T. A. and A. Stephenson, G. Tandy, and M. Spender, *Reps. Great Barrier Reef Expedition*, 3 (1931) 7–112.

[2] The expressions "lagoon" and "moat" were used synonymously by Darwin; subsequently however, "lagoon" has come to be restricted to the deeper tracts of reef-enclosed water (average depth 20 fathoms), while "moat" has become restricted to the shallow overflow channels (Steers, *Geogr. J.* 74 (1929) 252) characteristically found immediately inside the "ramparts" of coral shingle.

[3] *Reps. Great Barrier Reef Expedition*, 3 (1931) 22.

heavy rainfall, while practically none is experienced during the other nine months.

An important feature is the tropical hurricane, which is most common in the summer months. These cyclones generally sweep in from the Coral Sea following a parabolic course in an anti-clockwise direction, first south-westerly and then south-easterly. Sometimes they swing away to the south-east before reaching the coast, but often they strike the coast with extraordinary violence. The sector to suffer most is that between Cooktown and Townsville, particularly the immediate vicinity of Low Isles. A personal experience of a cyclone here in 1934 has been described by Moorhouse.[1] Although the heaviest swell may be expected from the north-east, the winds will normally blow in towards the moving cyclonic vortex, this time in a clockwise direction. Thus the island may be assailed at such times from any side.

As regards wave action in general, the orientation of the Barrier Reef lagoon (north-west to south-east) exposes it lengthwise to the South-East Trades, so that a moderate swell from the south-east is normal. It is similarly exposed to the rare north-westerly gale. On the other hand, the hurricanes coming from the north-east are somewhat barred by the continuity of the Outer Barrier and great median platform reefs in this area; nevertheless, the winds are undiminished by such undersea obstructions and a few miles to their lee the waves may again reach tremendous proportions.

Outside the Great Barrier Reef there is a single dominant current the year round, a steady longshore drift from north-west to south-east. To the interior, in the lagoon, conditions are complicated. In general however there is a set to the north-west (½ to 1½ knots normally) during the time of the South-East Trades, varied somewhat with eddy motions around the big reef platforms. Two additional factors may modify the currents: the prevailing tide (see below) and occasional hurricanes. The latter set up a secondary rotatory flow which, in combination with or in opposition to the normal current and tide, may result in a current of quite unusual speed and direction.

Tidal streams within the barrier are very important. In general the ebb stream (*i.e.* with the falling tide) tends to run north-east towards the barrier openings where a tremendous current is experienced (up to 6 knots), and the flood (rising tide) to run south-west. The combination of the normal tidal tendencies with the north-westerly set engendered by the South-East Trades generally results in a northward ebb and a southward flood.

Tidal oscillations in the northern section of the Barrier Reef lagoon are fairly regular, and with a combination of the diurnal and semi-diurnal constituents at springs there is a fairly big range. These exceptionally big tides occur in the tropics, especially at the solstices. For reef investigators this means only one workable tide a day; the other tide is almost obliterated. Thus it is important to know that in the winter solstice (June) the lowest tide is generally in daylight, while at the summer solstice (December) the reef is generally shrouded in darkness at the really low tides, which would effectively bar many types of field work at this season. Under cyclonic conditions tides may become abnormally banked up or even apparently reversed. Extraordinary anomalies can thus also occur in the tidal streams under these conditions.

[1] *Reps. Great Barrier Reef Committee*, 4 (1936) 37–44.

At Low Isles, preliminary tidal data were gathered by H.M.S. *Penguin* in 1905, and were recorded for almost a year by the British Expedition of 1928–29.[1] Datum was fixed by the *Penguin* at mean lower low springs. The lowest tides ever experienced drop to 4 or 5 inches below this and the highest rise to 10 feet 6 inches above. Mean sea-level was fixed at 4 feet 9 inches and mean high water level at 10 feet. Neap range is about 2 feet, while spring range is about 10 feet.

Previous work

Captain Cook, though he discovered the Low Isles in 1770, did not land,[2] and the next visitor, Captain King in 1819, also merely passed by. It was not until 1848 that a party landed under Captain Owen Stanley from H.M.S. *Rattlesnake*. It included the surgeon and naturalist MacGillivray and the young T. H. Huxley, his assistant. A short description is found in the journal of MacGillivray.[3] Subsequent Admiralty surveys have been concerned with the outline of the reef and off-shore soundings.

The first scientific investigation of Low Isles however took place in 1928–29, when the British Great Barrier Reef Expedition under Yonge made the Isles their base for twelve months. Two geographers, Steers from Cambridge and Spender from Oxford, accompanied the expedition (which was mainly biological) and their observations are extremely valuable.[4] The reef was revisited in 1931 by F. W. Moorhouse, a member of the British Expedition, who reported [5] a number of changes in the shingle ramparts. Moorhouse was also present at the time of the great cyclone of 1934, and this he reported in a second paper [6] which was illustrated with a useful map showing very extensive migrations of the shingle.

In 1936 Steers spent a second season on the Barrier Reef, and on this trip, described[7] in 1937, he visited a great number of island reefs of all sorts, as well as continuing his study of benches. His observations have considerable application to Low Isles. Especially interesting in a subsequent publication [8] are over three dozen sketch-maps of Barrier Reef islands and cays.

Present investigations

The present investigation was carried out as one of a series under the auspices of the Royal Australian Air Force, the object being to correlate ground features with their appearance on aerial photographs; in short, to improve the accuracy of photo-interpretation of coral reefs.

First, the Isles were photographed from the air in a series of overlapping verticals at 1500 feet (scale 1:3000) at 9 a.m. on 21 January 1945, with the

[1] *Geogr. J.* 76 (1930) 195, and 79 (1932) 201–9.

[2] W. J. L. Wharton, ed., 'Captain Cook's journal, during his first voyage round the world,' London, 1897.

[3] J. MacGillivray, 'Narrative of a voyage of H.M.S. *Rattlesnake*, 1846–50,' vol. 1, p. 101, London, 1852.

[4] For a general account of the expedition see C. M. Yonge, 'A year on the Great Barrier Reef,' London and New York, 1930.

[5] *Reps. Great Barrier Reef Committee*, vol. 4, pt. 1 (1933) 35–36.

[6] *Reps. Great Barrier Reef Committee*, vol. 4, pt. 2 (1936) 37–44.

[7] Steers, *Geogr. J.* 89 (1937) 1–28, 119–46.

[8] Steers, *Reps. Great Barrier Reef Committee*, 4 (1938) 51–104.

tide about 4 feet above datum. On subsequent days we carried out extensive low altitude reconnaissances of the northern Barrier Reef area, using large Martin "Mariner" flying-boats. Thus we were enabled to supplement the vertical photography with oblique views, always a useful combination. The value of direct observation from the air cannot be stressed too much. To see the entire subject in natural colours and in full perspective, and to be able to compare it with a whole series of other islands of the same type on the same day was a most memorable experience.

After the flights we were able to visit Low Isles between 30 January and 3 February 1945. Our visit fell in the height of the wet season. While a steady south-easter blew during much of our stay (as noted before, the influence of the North-West Monsoon is very secondary hereabouts), there was also a minor cyclone which swept down from the north and during which over 11 inches of rain were recorded. On a day of intermediate calm however, it was possible to row in the dinghy right over the zone of living reef around the south-east part of the Isles; for nine-tenths of the year this region is one of moderate to high seas and raging surf, exposed to the full force of the South-East Trades.

Our method of work was to take the air photographs in the hand, together with Spender's and Moorhouse's maps, and carefully check every feature on the ground. At almost all states of the tide it was possible to walk around most of the ramparts and, with the confidence provided by stout boots, we were able to wade over the reef flat at all except the highest tides.

We propose in this study to attempt a new analysis of the coral group that is Low Isles in the light of events there over the last seventeen years, and aided by our experiences in aerial surveys and in other coral assemblages. In another work, entitled "The rampart system at Low Isles, 1928–45," [1] we have gone into more detail on this particular aspect.

OBSERVATIONS IN 1945

Our first sight of Low Isles was from the air, and from afar one obtained the same impression as elsewhere in the Barrier Reef area, that there was such a lot of water and so little coral. However, descending to a thousand feet or so and slowly circling the Isles, we were able to spot most of the features we had found described in earlier works, though we were puzzled by a number of new features which we were to investigate later.

Being about mid-tide, the water covered the reef flat but left the rampart exposed, so that in reflected light one could imagine that there was actually a lagoon separating the two islets. The expression "pseudo-lagoon" has actually been used,[2] but, as Spender observes,[3] this is rather misleading for a flat which is almost entirely dry at low water, and subsequently Steers [4] rejects the term. But as the plane circled, the light changed; gone was the clear expanse of water, and with the light behind us the floor of the reef flat and even of the

[1] *Reps. Great Barrier Reef Committee*, 6 (1947) 1–16.

[2] C. Hedley and T. G. Taylor, "Coral reefs of the Great Barrier, Queensland," *Aust. Assoc. Adv. Sci.* 2 (1907) 397–413; Steers, *Geogr. J.* 74 (1929) 254.

[3] *Geogr. J.* 76 (1930) 200.

[4] *Geogr. J.* 89 (1937) 4.

living outer "fringe" showed up with crystal clarity. The slightly overhanging form of the latter and of the pinnacles of living coral heads was particularly clear.

The Sand Cay

The Sand Cay (Plate 2) is an oval islet, occupying about 3½ acres and measuring 700 by 300 feet at low tide, situated near the north-west end of the reef platform, just west of the Anchorage and midway between the extreme northern and western points of the horseshoe formed by the ramparts. It is orientated almost east–west, that is, at 45° to the prevailing wind, a characteristic noted by Steers [1] that it has in common with many other cays in the Great Barrier Reef area. A varied selection of flora vegetates the cay, including the deciduous *Terminalia* trees, Casuarinas, coconuts, *Tournefortia* bushes, etc. The sand is exclusively organogenic—coralline, molluscan, and foraminiferal in roughly equal parts; it is not really fine, as some authors state, but flaky, much of it being over 1 millimetre in diameter, and this coarseness is fairly uniform. A hand-boring carried out by Marshall and Orr [2] penetrated 14½ feet of similar sand without reaching bottom.

Only along the north and south sides is there any other material, the usual hard "beach-rock" of tropical islands. It is generally exposed from about 4 to 8 feet above datum. A growth of the small rock oysters *Ostrea mordax* is generally fixed to the lower part, and rises to a fairly constant line, as elsewhere on the Queensland coast, this being the level of mean neap high water (about 6 feet above datum hereabouts). The beach-rock is fissured by a rectangular jointing, parallel to the strike and dip, erosion tending to separate it into blocks a few feet square. In places its surface is being heavily eroded into abrupt little pot-holes, by chemical solution from the exterior (probably by sea-water) rather than by mechanical abrasion; but where covered up, it is clearly in the process of formation to-day. We encountered an interesting little demonstration of this: an old carbon battery had been thrown out and been caught in a chink of the beach-rock; it is now completely encrusted in beach sand to a thickness of about 3 to 5 millimetres and cemented to the rock. We may presume that in the interim it had been covered by sand, had received its incrustation from calcareous waters and then had been exposed again. The beach-rock, like the slope of the beach, dips at 5° to 7° to seaward, though the strike in places is somewhat divergent to the beach-line, suggesting slight variations in the latter from time to time.

A noticeable difference seen in the 1945 air photos in comparison with those of 1928 was the change in shape of the sand beach. Two small curving sand-spits had grown out to the south at the eastern and western ends of the cay. We remarked on this fact to the lighthouse-keeper, who assured us that this variation took place every year with the change of season. (The 1928 photos were taken in September, during southern "winter" and the period of the continual South-East Trades, while those of 1945 were taken in January, when northerly winds temporarily replace the Trades.) On February 1 we had proof of this; a near-cyclonic northerly gale blew for nearly twenty-four hours

[1] *Geogr. J.* 74 (1929) 249.
[2] *Reps. Great Barrier Reef Expedition*, 1 (1931) 119.

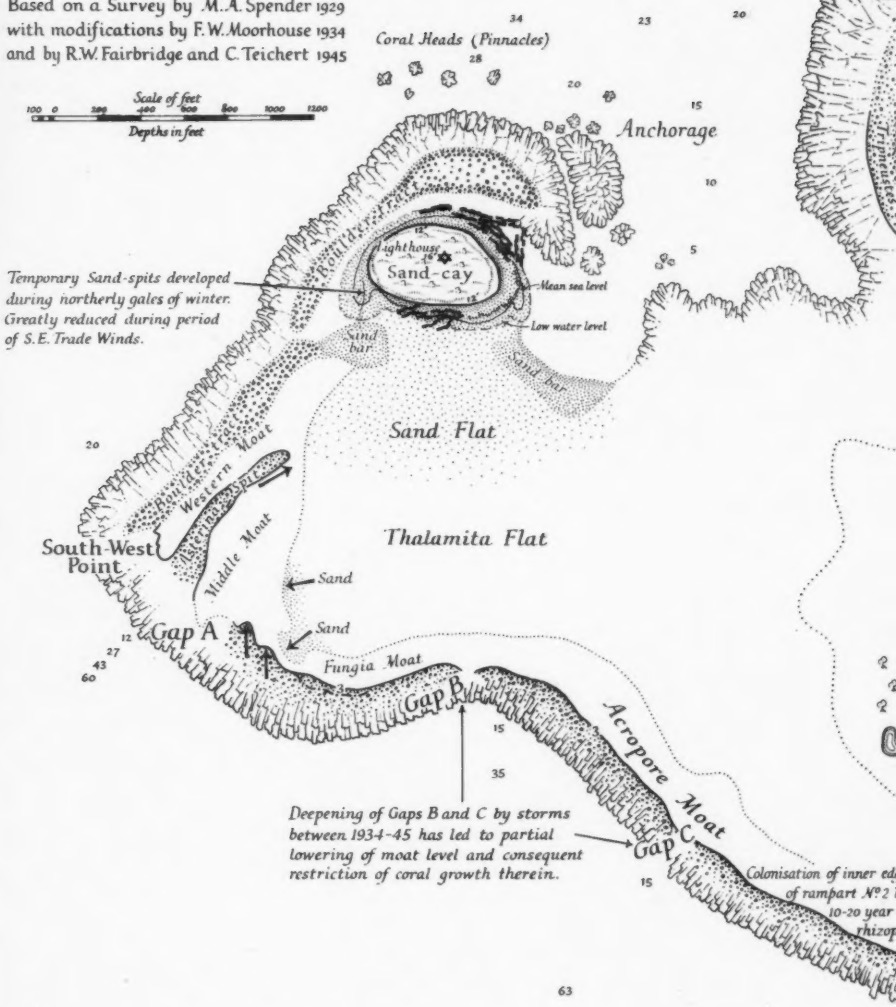
QUEENSLAND

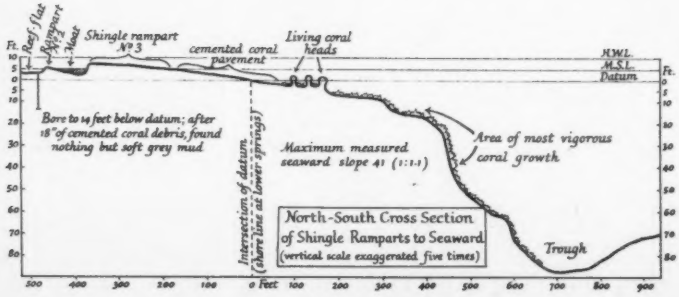
GREAT BARRIER REEF

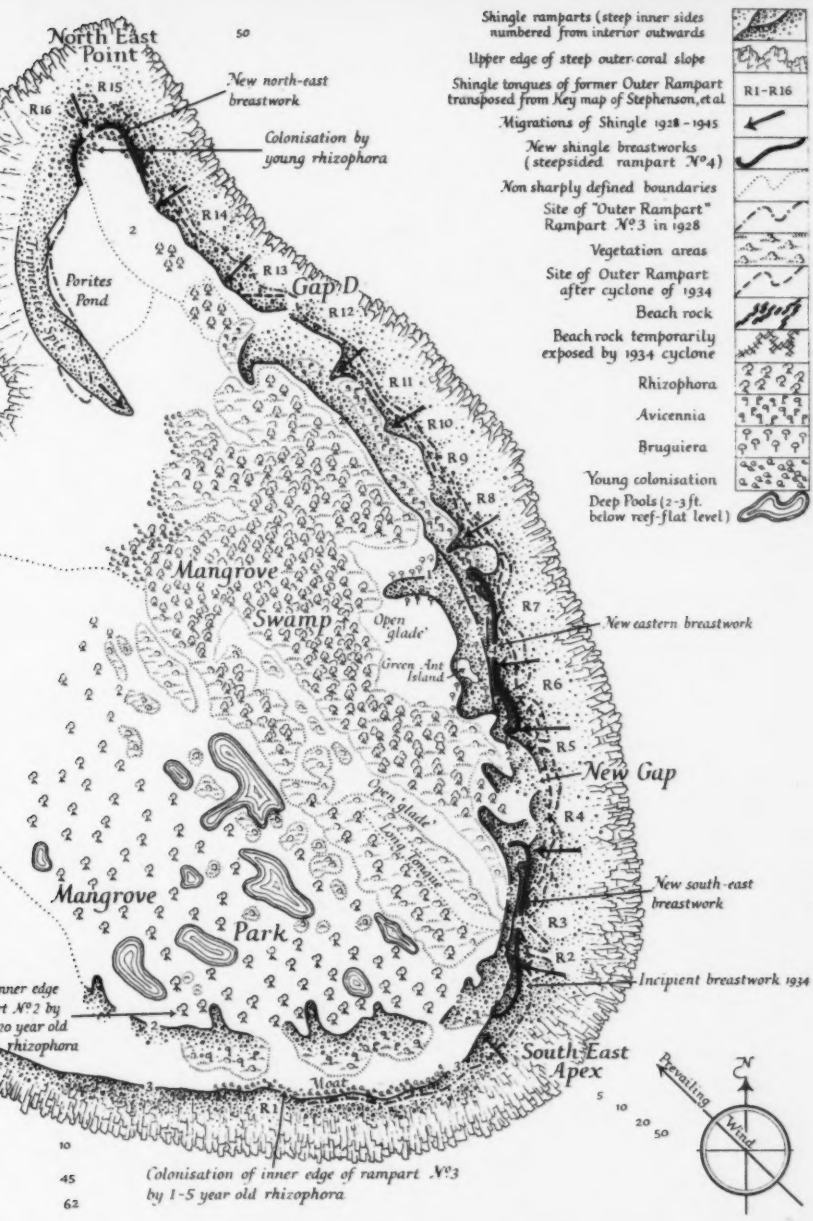
LOW ISLES

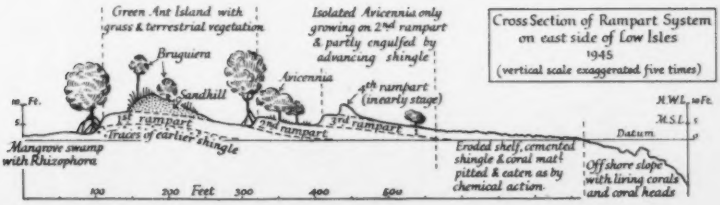
Lat. 16°23′S. Long. 145°34′E.

Based on a Survey by M.A. Spender 1929 with modifications by F.W. Moorhouse 1934 and by R.W. Fairbridge and C. Teichert 1945




Reef flat
Moat
Shingle rampart №3
cemented coral pavement
Living coral heads
H.W.L.
M.S.L.
Datum
Fr.
Bore to 14 feet below datum; after 18" of cemented coral debris, found nothing but soft grey mud
Intersection of datum (short line at lower springs)
Maximum measured seaward slope 41 (1:1.1)
Area of most vigorous coral growth
North-South Cross Section of Shingle Ramparts to Seaward
(vertical scale exaggerated five times)
Trough
500 400 300 200 100 0 Feet 100 200 300 400 500 600 700 800 900




Green Ant Island with grass & terrestrial vegetation
Bruguiera
Sandhill
Avicennia
Isolated Avicennia only growing on 2nd rampart & partly engulfed by advancing shingle
4th rampart (in early stage)
1st rampart
2nd rampart
3rd rampart
Traces of earlier shingle
Mangrove swamp with Rhizophora
Eroded shelf, cemented shingle & coral mat pitted & eaten as by chemical action
Off shore slope with living corals and coral heads
H.W.L. 10 Ft.
M.S.L.
Datum
Feet

Cross Section of Rampart System on east side of Low Isles 1945 (vertical scale exaggerated five times)

and at least doubled the size of the two curving sand-spits on the cay, laying bare more beach-rock on the north side of the Isles. This tends to substantiate Spender's remark [1] that "a sand-cay is a structure whose stability depends on the equilibrium of various opposing forces brought into play at the leeward extremity of a reef." This structure, he says, is rigidly determined during the steady South-East Trades although the sand is quite loose, but immediately equilibrium of wave and wind forces is altered by the advent of the northerly gales during the short wet season of "summer," the cay depends "only on its own inertia to resist being shifted to another position in the reef." In short, the sand-cay is nothing but a large sand-bank accumulated on the leeward side of the reef platform.

In general however during the last seventeen years there has been no fundamental change on the Sand Cay. The cyclone in 1934 destroyed numbers of trees and some of the buildings, but the physical position has been restored approximately to the original state, as was reported at the time of Steers' visit in 1936.[2] By comparison of the air photos however, it may be seen that the vegetation has developed considerably. Although as a result of the north-east direction of the 1934 cyclone all the eastern end of the cay was laid bare, exposing beach-rock in a continuous zone from the north around to the south-west, the sand and the beach-rock now appear much as they were before. Also seen to have resumed its normal place is the pumice-line, that fringe of small pumice lumps (1 to 3 inches in diameter) which is a characteristic feature of shores in Queensland and New South Wales.[3] It normally coincides with the highest limit of wave-swash at high water; thus on Low Isles it is about 12 feet above datum and just at the edge of the vegetation line. In the 1934 cyclone this line was carried up to the 15-foot level on the north-east side of the cay. There is now no sign of this material (shown on Moorhouse's map, 1936) and a new pumice-line is again found at the normal level.

The Mangrove Swamp

This forms the second of the two "isles," half a mile away across the reef flat to the east and south-east of the cay, where it covers about 50 acres. Here it lies protected from the south-east storms by the well-developed rampart system, although the floor of the swamp itself is mostly less than 2 to 4 feet above datum and is thus covered by water a great deal of the time. The water is generally still except during the north-westerly winds. The flora of the swamp is almost limited to the "Black Mangrove" (*Rhizophora mucronata*)[4] which grows to a height of 60 to 70 feet.

[1] *Geogr. J.* 76 (1930) 200.

[2] *Geogr. J.* 89 (1937) 134.

[3] It is perhaps not very well known outside Queensland and New South Wales that such pumice material is constantly being washed up on the beaches here. It appears to come from volcanoes in the New Britain–Solomons–New Hebrides area. C. Hedley exhibited an example to the Linnean Society of New South Wales (*Proceedings*, 1905, p. 351), which had been washed ashore on the Sydney beaches in enormous quantities in 1904; he traced it back to a submarine eruption off Tanna, New Hebrides, some four or five months before, having been carried down 2000 miles on the powerful southerly current.

[4] Some authors give this *Rhizophora* as "Red Mangrove." According to F. M. Bailey's 'Comprehensive catalogue of Queensland plants' (1912) it is "Black." *Avicennia*

The margin of this area is fairly well defined, by the ramparts to the north and east and by the open "glades" of the Mangrove Park to the south and west. Comparison of the 1928 and 1945 air photos shows a slight development of mangrove growth by the filling up of smaller "glades," but on the whole there is no marked change. The destruction referred to by Moorhouse [1] now seems to have been repaired. (For the spread of mangrove in the Reef Flat, Mangrove Park, etc., see below under those headings.) Within the area of the mangrove swamp there are several identifiable patches of shingle material which are slightly above the general level of the swamp. They are marked by an absence of *Rhizophora*. There is in particular a "Long Tongue" which runs north-west to south-east along the south-western side, a feature which makes interesting comparison with similar shingle tongues on Two Isles and Three Isles lying farther north in the Barrier Reef Lagoon.

The floor of the swamp is composed of a soft black calcareous mud, forming a layer up to 6 feet deep resting on the normal sandy material of the Reef Flat. A bore put down by Marshall and Orr [2] to a depth of 12½ feet went through grey mud into a mixture of sand and coral shingle. It has been suggested by Spender [3] and others that the mangroves themselves manufacture this black mud by acidifying and dissolving the calcareous ground on which they grow. Stephenson *et al.*[4] make mention of decay bacteria liberating carbon dioxide, an associated process, but do not enlarge upon the matter. Wharton [5] and Fryer [6] have already noted the destruction of coral limestone by mangrove at Aldabra in the Indian Ocean.

The Shingle Ramparts

Characteristic of the low woody island-reef are the ramparts of coral shingle, "conglomerate" or "breccia" (also called "clinker" by some authors, including Dana and Hedley) which encircle the reef platform like a horseshoe, open to the north-west. At most states of the tide the ramparts appear above sea-level and thus shelter the waters of the Reef Flat. These ramparts, or ridges of coral shingle, consist of debris broken off from the living reef and cast up by the waves to the limit of their reach. The upper parts of the living reef fringe

is referred to in Queensland as the "White or Grey Mangrove." Elsewhere however, *e.g.* in the Philippines and Florida, it may be noted that *Rhizophora* species are generally known as "Red Mangrove," *Avicennia* as "Black Mangrove," and *Laguncularia* as "White Mangrove."

[1] *Reps. Great Barrier Reef Committee*, 4 (1936) 37.
[2] *Reps. Great Barrier Reef Expedition*, 1 (1931) 119.
[3] *Geogr. J.* 76 (1930) 290.
[4] *Reps. Great Barrier Reef Expedition*, 3 (1931) 70–1.
[5] W. J. L. Wharton, "Mangrove as a destructive agent," *Nature* 29 (1883) 76–7.
[6] J. C. F. Fryer, "The south-west Indian Ocean," *Geogr. J.* 36 (1910) 251–71.

Plate 1. Low Isles from the north

Plate 2. Vertical view of the Sand Cay in 1945

1. Lighthouse; 2. Sand spits; 3. Beach rock; 4. Sand flat; 5. Northern moat; 6. Boulder tract; 7. Coral heads; 8. Submerged living coral at western edge of Anchorage

Phot. R.A.A.F.

1
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in particular consist largely of quick-growing and fragile "Staghorn" coral (*Acropora*), and fragments of these corals make up a very large percentage of the shingle. Other coral as well as molluscan species contribute in great variety, but as regards bulk do not compare with *Acropora*. It is the branching or interlocking character of these fragments that gives the ramparts their remarkable resistance, especially those which are older and somewhat cemented.

The ramparts are highest and most developed to the east and south-east, the direction of the heaviest prevailing seas, and have the characteristic of forming high spits, or rather tongues (an expression preferred by Steers, Spender, and Kuenen). These project some distance on to the reef platform and bestow a curious inverted cuspate or scalloped pattern on the inner edge of the ramparts. The origin of these tongues has puzzled earlier workers.

A study of air photos reveals how every wave breaking obliquely to the coast is gradually deflected inwards, so that in the shallows beyond the breakers (at high tides) there are two converging sets which will tend to develop tongues. If the coast is curving, then the wave deflection increases progressively and the tongue will tend to curve too—a common feature in the oval-shaped low woody island-reefs. The elevation of these spits is generally higher than that of the rampart on either side so that it is not a question of shingle being carried through a gap in the ramparts. On the contrary, the waves come over the lower sections of the ramparts (only at highest tides, of course), "shepherding" the debris with them, always being deflected more and more in towards the spit. Thus the spit may extend, under the continued action of the Trade Winds, for a great distance on to the Reef Flat, up to 500 yards or more on some islands. Big shingle tongues of this sort were particularly built up by the 1934 cyclone [1] when two converging sets of waves struck the north-eastern ramparts with exceptional force.

The undulating or cuspate inner edge of the rampart presents a well-marked line, as the rampart is normally asymmetric in cross-section, having a short steep inner slope dropping 2 to 4 feet at a gradient of 45°, and a long gentle outer slope of 2° to 5°. Thus it is that the outer edge is obscured beneath the edge of the succeeding rampart, or, if it is the outermost, merges indistinguishably with the reef margin. Most of the ramparts are well elevated, reaching 5, 8, and even 10 feet above datum around the south-east and east sides. There are lower "gaps" however here and there, where the water pours

[1] Moorhouse, *Reps. Great Barrier Reef Committee*, 4 (1936) 38.

Plates 3 and 4. Vertical views of north-east point: above, in winter 1928 at low tide with slight swell from the south-east; below, in summer 1945 at high neap tide with heavy swell from south-east trade wind

1. Northern limit of mangrove swamp; 2. Inner or second rampart partly overgrown by "Avicennia"; 3. Outer or third rampart; 4. Shingle flat; 5. Site of Spender's "B" beacon and "shingle mound"; 6. Site of north-east moat; 7. Porites pond, sandy floored with living Porites corals; 8. Sand flat darkened by mangrove mud and weed; 9. Tripneustes spit of sand overlain by shingle; 10. Submerged living coral at eastern edge of Anchorage; 11. New breastwork of coral shingle built up since 1934

Phots. R.A.A.F.

out at ebb tides and in at the flow; the level of these gaps is now about 1 to 2 feet above datum.

At Low Isles, Spender and others depicted and described an "Inner" and an "Outer" Rampart. The outer was described as loose and somewhat unstable, tending to advance over the inner, which on the other hand was mostly blackened with age, generally firmly cemented and extremely hard. This however seems to be an oversimplification, and the terminology is bound to break down when more than two ramparts are developed. The material for the rampart-building is continually being accumulated as a result of the wave attack on the ever-growing coral of the reef fringe.

As already suggested by Spender,[1] the ramparts represent successive periods of accumulation of this debris; Stephenson too has pointed out the cyclic nature of this process.[2] The material for the rampart can presumably only be carried a certain distance over shallow water by the force of the waves before the latter becomes dissipated. Storms and cyclones will gradually cause the rampart to move inwards, until a critical point is reached when a new system will start to form outside the first. Thus, as the living coral fringe grows farther and farther out, second, third, and fourth ramparts will follow the first, each more or less parallel to the other a little farther to the exterior. It is not suggested that any one of these ramparts is necessarily precisely contemporaneous along its whole extent, nor that succeeding ramparts represent specific time stages. In other words, it seems quite likely that the fourth rampart is beginning to form in exposed parts while the third is still accumulating along more protected parts of the shore. It is not necessary to postulate any oscillation of sea-level or geological movement to account for this outward growth.

In the most highly developed area, to the east and the south-east, we identified thus four rampart lines (see section inset in map facing p. 74), not including possible remnants of still earlier rampart systems now more or less completely submerged in the Mangrove Swamp.

First rampart.—This is the oldest and innermost, clearly-defined rampart, consisting of the sand-crowned spit now preserved as "Green Ant Island," with certain "glades" to the east of the Mangrove Swamp. One of the latter is actually a typical curving shingle tongue, 80 yards in length. The rampart consists of very black, firmly cemented coral fragments, the surface of which is severely corroded in places. Characteristically it has a steep inner slope towards the Mangrove Swamp. The outer slope is gradual towards the steep inner edge of the succeeding rampart. The rampart itself is only just discernible from the air, being heavily overgrown with *Bruguiera*, a mangrove characteristic of this small area alone. In the sandy places there is a miscellaneous vegetation including terrestrial grasses and trees. There are no *Rhizophora* or *Avicennia* on this rampart and it is this change of vegetation respectively from the Mangrove Swamp on the one hand and from the second rampart on the other which is so clearly visible on the aerial photos. On Spender's map this rampart is indicated as a shingle area inside the Mangrove Swamp and not as a rampart at all. There can however be little

[1] *Geogr. J.* 76 (1930) 209.
[2] *Reps. Great Barrier Reef Expedition*, 3 (1931) 96.

5. Aerial view from the east

6. Aerial view of south-western point

doubt as to the analogy of this rampart with those recognized by the British Expedition.

Second rampart ("Inner Rampart" of Stephenson, Spender, *et al.*).—This overlaps the outer edge of our oldest rampart, resting on it at 2° to 3° (sloping outwards). Its thickness is usually 2 to 4 feet. Except for some 300 yards near Green Ant Island and to the north, it generally forms the innermost rampart. In this way it may be traced from the southern side of the Mangrove Park to the north end of the Mangrove Swamp. Like the first rampart, it consists of a blackened and corroded coral conglomerate or breccia and is generally vegetated. The characteristic flora is the "white mangrove" (*Avicennia officinalis*), the trees stunted and bent over almost double, and so clustered together that from the air they present a smooth, velvety appearance. In places there is the fleshy, green creeper *Sesuvium*. According to the air photos, the inner edge of this rampart has not moved at all in the intervening seventeen years, but the growth of *Avicennia* has extended considerably, especially in the east and north-east. In places however this rampart has been practically overwhelmed by the advance of higher and outer ramparts. Its relations in the south part of the reef platform can be seen in Plate 5.

Third rampart ("Outer Rampart" of Stephenson, Spender, *et al.*). This is the most complete and best developed of all the rampart systems and it encircles almost the entire reef platform. It is mostly quite loose or only partly cemented (*e.g.* to the south and north) and like the other ramparts varies from 2 to 4 feet in thickness, overlapping its predecessor. It consists of blackened and corroded coral fragments, which in part seem to be derived from the underlying second rampart. It was the great cyclone of 1934 that destroyed the parallelism of this "Outer Rampart" with the "Inner Rampart." As Moorhouse reported,[1] the cyclone coming from the north-east drove the whole "Outer Rampart" bodily inwards all along the northern and eastern sides of the Isles. It can be seen from the latest air photos that the process has gone even further since then.

The whole appearance of the northern end of the rampart system has changed. There was formerly an inverted V-shaped plan to its northern end, the point of the "V" to the north crowned by a "Shingle Mound." In 1934 this mound was flattened and moved in somewhat, encroaching on to and obliterating the "North-east Moat" which lay to the interior. By 1945 it had swung down and formed a U-shaped ring reaching to the north point of the "Porites Pond," and was crowned by a higher ridge or breastwork (see below under "Fourth rampart").

A feature of the northern and western extremities of the platform at Low Isles is an almost symmetrically arranged pair of long incurving spits which extend up to 300 yards on to the Reef Flat. The northern one begins with the south-west arm of the U-shaped rampart, and grades out from coral shingle to a simple sand spit (the "Tripneustes Spit," so named after a sea-urchin found there), curving down almost to the north-west edge of the Mangrove Swamp. At the opposite, western point of the platform, the "Asterina Spit" (named after a common star-fish found there) throws out a similar recurving horn towards the Sand Flat (Plate 6). This spit is exclusively coral shingle. The

[1] *Reps. Great Barrier Reef Committee*, 4 (1936) 39.

Tripneustes Spit has not preserved its original form unchanged, having swung some 50 yards inwards (Plates 3 and 4). The Asterina Spit has almost doubled its length since 1934.

Fourth, or outermost, rampart.—This rampart seems to have been formed since 1928, probably even since 1934. It overrides and rests upon the "Outer Rampart" of the British Expedition reports, and it is now well developed in several places along the east side of the reef.

Three sections of this rampart are particularly striking. In the south-east it forms an almost straight ridge, about 270 yards long, with compound incurving spits at each end. It appears to have been built up by the welding together and further accumulation of the two "breastworks" observed by Moorhouse [1] after the 1931 storms. In the east it forms a ridge slightly concave to the outside, 250 yards long, with compound, incurving horns at the north end and a single, pronounced hook at the south end (see Spender's "Incipient ridge"). In the north it forms the northern and western part of an inverted U-shaped ridge at the extreme north end of the reef platform, crowning the encroachment of the third rampart from the former "Shingle Mound," to form a wall reaching down to the northern point of the "Porites Pond."

The fourth rampart is built of fresh, unblackened coral fragments with an admixture of greyish, somewhat more intensely weathered coral debris undoubtedly derived from the older third rampart. On the whole it is very light coloured, contrasting strikingly with the dark greyish colour of the third rampart on which it rests. It shows up very clearly in vertical aerial photographs. The top of this rampart is only about 2 feet wide and rises to about 10 feet above datum. The inner slope is very steep as usual (about 45°), but unlike other ramparts the outer slope is also fairly steep, though generally not more than about 30°. This however is very much steeper than the outer slopes of the earlier ramparts, and has led to the use of the expression "breastwork" for these wall-like shingle ridges.

The Boulder Tract

Across the north-western or open side of the horseshoe formed by the ramparts, the symmetry breaks down somewhat. Near the centre lies the Sand Cay. To the north-east of this there is a complete gap with the "Anchorage," but to the south-west and actually surrounding the cay to the north there is another shingle ridge zone of coral debris called the "Boulder Tract" by members of the British Expedition. This Boulder Tract occupies an analogous position to the rampart system of the horse-shoe, but being protected from the South-East Trades has a rather different structure. Instead of well-worn *Acropora* fragments, 3 to 4 inches in length by 1 inch in diameter, we have a ridge of bouldery debris characterized by coral boulders ranging from 6 inches to 3 feet in diameter. Crowning all is a variety of scattered negro-heads, ranging from 3 to 8 feet in diameter. Normally only these negro-heads show above water, but at low springs the whole tract is exposed.

As Spender pointed out,[2] since there is the richest growth of coral at only

[1] *Reps. Great Barrier Reef Committee*, 4 (1933) 35.
[2] *Geogr. J.* 76 (1930) 203.

2 feet below datum in these normally protected waters on the north-west of the reef, and as these colonies are often overhanging or supported on the slenderest of pinnacles, it is to be expected that during the rare storm from the north-west these coral heads will become broken off and cast up on to the edge of the reef platform, to form what Spender calls simply "boulders." [1]

The Reef Flat

The entire area of the reef platform within the ramparts, apart from the cay and Mangrove Swamp, are included in this general title, the "Reef Flat." Its topography is not unlike an upturned saucer, about 3 to 4 feet above datum at the centre and dropping round the edges to datum level or even below. The superficial sediments are mostly sands, coral muds, dead coral debris, and "honeycomb-rock." [2] This honeycomb-rock is found mostly in the western half of the Mangrove Park, also broken up in the eastern half. In addition it is found in a narrow zone (see under "Seaward shelves," p. 83) outside the outermost ramparts in the south-east at lowest tide levels. The rock occurs in slabs and pavements, severely rotted and overgrown with algae or weed. It consists of reef debris, coral and algae with molluscan fragments, cemented together partly by algae and probably partly by bacterial precipitation as well as by normal evaporation. It appears to be rotting away in places, by acid from decay bacteria [3] and other sources. There does not appear to be any massive dead coral left in place anywhere on the Reef Flat, though coral is growing to-day in the deeper ponds and moats. Bores put down by Marshal and Orr [4] at various points on the reef platform to about 15 feet, although unfortunately nowhere on an area of honeycomb-rock, showed no dead coral in place but only grey coralline mud. The surface of the Reef Flat is nevertheless firm, no quicksands or mud pockets being encountered. It is subdivided into four areas as follows:

(*a*) *The Sand Flat* occupies most of the area south of the cay and between the latter and the Mangrove Park (see below). The average level is 3 feet above datum. It is relatively unchanged after seventeen years and is not an area where one would look for modifications except in the precise alignment of sand banks and so on. Such slight changes do in fact occur.

(*b*) *The Thalamita Flat* occupies the slightly deeper area (average level 2 feet above datum) south of the Sand Flat, the transition from which is quite

[1] We prefer to adhere to the widely-used term "negro-head" as indicating the largest-sized boulder of dead coral which is commonly found on top of exposed reef crests. Pinnacles of living coral below low tide may be known as "coral-heads." In Queensland, both of these completely different features are referred to colloquially as "niggerheads." Flinders' definition ('A voyage to Terra Australis,' vol. 2, p. 88, 1814) was clear enough: "The negro-heads were lumps which stood higher than the rest; and being generally dry were blackened by the weather; but even in these, the forms of the different corals and some shells were distinguishable."

There seems to be nothing in this definition that might lead to confusion with submerged living "coral heads," nor is there any reason to follow the example of those who have changed the term to "niggerheads." See also note by Umbgrove in *Proc. Kon. Ak. Wet., Amsterdam*, vol. 34, no. 3 (1931) 485–87.

[2] *Reps. Great Barrier Reef Expedition*, 3 (1931) 52.

[3] *Reps. Great Barrier Reef Expedition*, 3 (1931) 70.

[4] *Reps. Great Barrier Reef Expedition*, 1 (1931) 118.

gradual, grading evenly down into the zone of moats to south and south-west. The floor of the Thalamita Flat (so called after a small crab common here) is sand-littered with irregular boulders of dead coral and "honeycomb rock" together with the large shells of *Tridacna* and *Hippopus*. In the deeper pools there are even living corals. Large seaweed is not prominent but algae are common. The past seventeen years have altered this area but little. Only in the south-west does there appear to be a slight advance of the loose sediments on to the corals of the Fungia Moat (see below) in the form of two spits.

(*c*) *The Mangrove Park* is the area between the Sand Flat and the Mangrove Swamp, reaching right down to the ramparts of the south-eastern extremity. Scattered about the area there are clumps of healthy-looking mature mangrove (*Rhizophora*) while young plants appear to be rapidly spreading, particularly to the north-west and south. The average level is about 4 to 5 feet above datum, that is, somewhat higher than anywhere else on the Reef Flat. The floor consists mostly of "honeycomb-rock" with extensive algal incrustation, and is generally strewn with sand. The whole area is covered by a green tape-like seaweed *Thalassia Hemprichii*, which gives it a park-like appearance at all but high tides. In parts however there are deep pools with coral mud floors, reaching down as much as 2 feet below the general level. These pools do not dry at low tide and support a considerable variety of life, seaweed, mollusca, echinoids, sea-slugs, bêche-de-mer, fish of all sizes up to sharks, and large sting-rays. The interesting feature is that they contain no corals at all. It seems likely that the concentration of carbonic acid and other deterrents from the adjacent mangroves is prohibitive for coral growth.

How did these pools arise? Our considerations on the manufacture by mangrove (of the *Rhizophora* type) of their own soft muddy substratum, by interaction of their various acids with the calcium carbonate of the floor, led to the conclusion that in the vicinity of mangroves calcareous rock will be destroyed and removed, partly in solution and partly in suspension as fine mud which is easily caught up and carried away by the tide. The deep pools thus appear to be the sites of former *Rhizphora* growth, as may be also some of the open "glades" in the Mangrove Swamp.

Although it received a "severe handling" in the 1934 cyclone, the Mangrove Park has apparently recovered completely; in fact, during the last seventeen years a very noticeable development of the *Rhizophora* growth has taken place. Not only have the existing clumps become enlarged, but large numbers of young plants are now getting a footing out on the Reef Flat to the north, west, and south. To the north, the new settlements extend right to the edges of the Tripneustes Spit and the Porites Pond, while to the south they seem to have advanced as far as the edge of the second rampart where they have found a firm foothold, so that this line is now marked by a growth of *Rhizophora* at least 3 to 6 feet high. Recently specimens have even reached the inner edge of the third rampart in this area. The young *Rhizophora* in this way form striking "fringes" along the inner margins of shingle ramparts. It would seem that these sites offer a good foothold, while tidal scour prevents fixation for the most part in the moats and channels.

(*d*) *The Moats* are a series of water channels to the interior of the ramparts, forming the deep marginal parts of the Reef Flat. In 1928 the water

behind the ramparts tended to become dammed up in these moats, and a plentiful development of living coral could be found there since there was always a foot or so of water even at low tide. At the extreme northern and western ends of the Reef Flat the channel widened out into symmetrically placed, shallow basins, the "Porites Pond" and the Middle and Western Moats respectively.

The cyclone of 1934 however had a catastrophic effect on the moats of the northern and eastern parts of the platform, and the air photos of 1945 show that the process has continued. As Moorhouse pointed out, the storm broke down many of the "dams," the water pouring away at low tide. The Porites Pond in the extreme north has been severely restricted by the development of the new U-shaped rampart described above. The North-east Moat was completely overwhelmed by the encroachment of the outer rampart along the eastern margins, while the vestigial moats in the east were also overwhelmed. In the south-west, the "Acropore (Madrepore) Moat" is mostly intact. The "Fungia Moat" on the other hand is very greatly restricted by mutual invasions of the rampart and of the Thalamita Flat. In the west, the Middle Moat has been almost cut off from the Western Moat by a striking advance of the Asterina Spit, which has made the latter very long and narrow (Plate 6). North of the cay the Northern Moat has been narrowed by the flattening of the boulder tract. Thus it is that the impression of a "moat" behind the "ramparts" is no longer very marked.

The seaward shelves

To seaward of the outermost rampart, the loose shingle passes down and outward into a hard, cemented coral breccia, which occupies a zone up to 200 feet wide and ranging from about 4 feet above to a little below datum. It is best developed in a crescent around the south-eastern apex of the isle (the windward shelf) with other sections in the south-east and north-west. It has been described as "a pavement of pitted honeycomb-rock" and is overgrown in places with a "felt of algae" [1] and sparsely littered with small boulders and debris. The actual rock itself, as Steers has shown,[2] is nothing but "lithified shingle beaches." In appearance this rock is pitted and etched out by chemical solution to present a very jagged surface, not smoothed and rounded as would result from mechanical abrasion. In view of its low elevation, it seems impossible that this erosion is other than chemical solution which has been carried out under certain physico-chemical conditions by sea-water.

The Anchorage

In the north-west, between the cay and the northernmost point of the flat, the edge of the reef platform is indented and the continuity of ramparts or boulder tracts and moats is broken. An anchorage is here provided where small vessels can anchor in comparative safety, less than 200 yards from the cay. Its edges are fringed with living coral and dotted with pinnacles or "heads" of living coral. The whole centre of the Anchorage however is floored with clear

[1] *Reps. Great Barrier Reef Expedition*, 3 (1931) 65.
[2] *Geogr. J.* 74 (1929) 253.

white sand. It is not deep but shelves gently from 3 to 5 feet below datum at the coral edge down to 15 feet in the centre. From the aerial photographs it can be seen that the coral has grown a recognizable amount in the intervening seventeen years; odd patches have fused together, and coral heads have grown larger. Otherwise there is nothing new to report.

The seaward slopes

The seaward slopes of the platform have been briefly described by Stephenson *et al.*[1] and in more detail by Manton.[2] The slope is everywhere covered with masses of dead coral, and between these and on top of them there is living coral growth of varying intensity. This fringe of living coral shows up very well when seen from the air.

CONCLUSIONS

We have thus seen how Low Isles have fared in seventeen years. The corals have been growing, but the waves have been pounding and the exceptional 1934 cyclone left an unmistakable mark on the isles. The question to be asked is, are the islands growing, shrinking, or stable? No clear picture resulted from the work of the British Expedition. Steers gave us an evolutionary interpretation, according to which different islands of the "low wooded island" belt represented different stages of a continuous development; in the course of time the less advanced islands would be seen gradually maturing. Spender, on the other hand, believed that the "island reefs" (Steers' "low wooded" type), of which Low Isles is an example, had to-day reached a stage of "comparatively stable and balanced finality," and that their physical features were essentially determined by the position of the reef platform relative to sea-level. These theories may now be tested in the light of some new facts. As Steers has said, coral reefs are a somewhat controversial subject, and it is therefore in the nature of things that we should agree with some observers and disagree with others.

Coral islands such as Low Isles are structures which originate as a result of a number of biological and geological processes which are essentially irreversible. If these take place gradually and continuously, they may result in directional or "evolutionary" changes; an even, upward gradient or "evolutionary equilibrium" would be attained; but it might be upset at any time if one or several of the processes responsible for it changed suddenly. Both geological and biological processes are not only irreversible, they are also cumulative in their effects. In other words, they lead to gradual changes in the distribution of matter. Such changes may be positive or negative. "Stability" is attained if at any particular time and in any particular place positive and negative changes are in equilibrium; that is, if the amount of matter added is equal to the amount of matter lost. It would appear that stability in Nature is only one of an infinite number of possibilities, just as the circle is a special case of the ellipse.

With this preamble in mind we may ask ourselves whether our review of the history of Low Isles during the last seventeen years shows any evidence of

[1] *Reps. Great Barrier Reef Expedition*, 3 (1931) 64.
[2] *Reps. Great Barrier Reef Expedition*, 3 (1935) 273.

directional or "evolutionary" changes. One tendency is obvious; corals must have been growing all the time and the fringe of living reef surrounding the platform must have increased in bulk. This is shown by direct comparison of the 1928 and 1945 photographs of the coral reefs in the Anchorage and may be confidently presumed to have occurred elsewhere on the island. But this biological growth in itself would not necessarily lead to an increase in bulk of the island, because it is conceivable that physical agencies remove matter at very much the same rate at which matter is added. However, the recent history of Low Isles does offer certain evidence of progressive changes.

In the first place, there is evidence of the movement of coral shingle: the inward advance of the outer ramparts, the filling-in of the moats, the growth of spits, and the formation of new ramparts on the outside. The inward advance of the outer ramparts leads to a filling-in of the moats and to the extinction of the life flourishing in them. The effect is that of making the Reef Flat more uniform and converting it more and more into a surface of dead coral sand and shingle. Meanwhile, fresh coral is growing and being broken off the reef fringe and thrown up on to the edges of the platform, thus tending gradually to increase its diameter.

Secondly, the mangrove is spreading on the Reef Flat. A comparison of the air photos of 1928 and 1945 shows that patches of mangrove have been expanding and coalescing everywhere. There has been considerable extension of *Avicennia* in the north and even on to the ramparts in the east, south-east, and south. On the ground, young *Rhizophora* plants could be seen spreading rapidly over the whole area of the Mangrove Park and advancing to the west and north of it. Also, north of the Mangrove Swamp there is now a vigorous expansion of young *Rhizophora* growth as far as the outer limits of the Porites Pond. It seemed to us that it would only be a question of time until most of the Reef Flat would be covered with dense mangrove growth and would then present an appearance very similar to that described from some of the low wooded island-reefs farther north, such as Bewick Island, Houghton Island, or Low Wooded Island itself.[1]

We were fortunate in being able to view a series of these "low wooded island-reefs" one after another in quick succession from the air. Benefiting enormously from the previous work of Steers, Spender, and others, and with their maps on our knees, we were able to obtain an impression of numerous reef types of this "island reef" belt, from almost completely submerged reefs such as Cee and Dee Reefs near Cooktown, to the mature wooded island like Three Isles or Low Wooded Island with their elevated coral "pavements." Nobody could avoid the impression that these various reef types present stages in an evolutionary process which led inevitably from the submerged reef stage, through the formation of a sand-cay and the establishment of a mangrove forest on the rampart-protected Reef Flat, to the end stage at which the entire reef platform is covered with vegetation.

However, a consideration of certain physical features of Low Isles and a study of what little is known of its history prior to 1928 teaches caution and may prevent us from rash generalizations. A study of the deep pools in the Mangrove Park, as we have seen, prompts the idea that mangrove vegetation

[1] Steers, *Reps. Great Barrier Reef Committee*, 4 (1938) 51.

was once more extensive on the Reef Flat and that at some time the tide of growth may have turned and the mangrove disappeared from areas which it once covered.

It is of some interest that observations of early travellers [1] suggest that such changes may have occurred in comparatively recent times. When Captain Cook passed the spot in 1770, he mentioned the existence of one island. Forty-nine years later Captain King passed the island in H.M.S. *Mermaid* and recorded three distinct isles, noting [2] that "they are laid down by Captain Cook as one island, whereas they are distinctly three, but all connected by a reef which was covered when we passed." In 1848 Captain Owen Stanley in H.M.S. *Rattlesnake* recorded two isles, a low sandy island to the north-west with "one or two clumps of mangroves growing near the eastern edge of the reef." The surgeon of that vessel, MacGillivray, mentioned three islets, clearly regarding the "one or two clumps" of mangrove as two. From a contemporary sketch, Spender notes that the two clumps of mangrove appear to have been narrowly separated, one occupying the position of the present northern part of the Mangrove Swamp, while the other lay in the position of the present Mangrove Park and was connected with the relics of the "Inner Rampart," still seen to-day, at the south side of the island. It thus appears likely that the mangrove, at least on the part of the Reef Flat known as the Mangrove Park, had degenerated during the preceding century. The evolution was a regressive one. When the turn to the present progressive stage occurred, it is not possible to say, though it must have been near the end of the last or the beginning of the present century.

The retrograde processes are less obvious at Low Isles than the constructive. However, they exist none the less, for example:

(i) *Tides and currents.*—While the pounding surf of the South-East Trades is continually throwing up fresh debris on the one side, there is a powerful current at low tide carrying the finer material off the Reef Flat and away to the lee side of the isles. There is a long "tail" of coral sand on the sea floor lying in that direction.

(ii) *Increased sedimentation.*—It is possible that the optimum conditions of coral growth which formerly existed may be reduced indirectly by the activity of man. The colossal soil erosion during the last decade or so, engendered by unplanned agriculture in the drier parts of Australia, finds evidence even in the coral seas. Ships at sea complain of the blinding dust-storms, the sea assuming a reddish-brown shade. River-borne sediments are also increasing. After extremely heavy rains during our visit in January–February 1945, we observed that the heavily mud-charged waters of the Daintree river were carried far out to sea, well past Low Isles, making the waters there completely turbid. The current must have been quite strong. After a particularly heavy storm, two live frogs were found cast up from this muddy stream on to the outer ramparts here, some 8 miles from land. We obtained thus an impression, possibly distorted, that continental sedimentation might soon be gaining on coral growth at Low Isles. Certainly amongst the coral of the seaward slopes sedimentation appeared to be playing some amplified rôle.

[1] Also cited by Spender, *Geogr. J.* 76 (1930) 212.

[2] P. P. King, 'Narrative of a survey of inter-tropical Australia,' p. 207, London, 1827.

Much of the coral was dead and coated in a "fur" of fine brown terrigenous sediment.

(iii) *Acid action in the Swamp.*—Another feature which does not appear to have received much attention in the past is the action of acids (carbonic, sulphuric, tannic, or other) from the Mangrove Swamp in attacking the coral material of the floor of the Reef Flat. In this way, calcium carbonate, which was previously removed from solution in sea-water by the action of the corals and other organisms, will be liberated as calcium bicarbonate by acids rotting the coralline material. In addition, the hard coralline floor will be disintegrated by this decay process, enabling currents to carry finer grained but insoluble material away in suspension.

(iv) *Chemical solution by sea-water* of coral and coral limestone seems to be a feature of the seaward shelf or bench, but is apparently restricted to the inter-tidal zone, as noted already by Kuenen.[1]

If it is possible to make any generalizations from this study of the most recent history of Low Isles, it would seem that the growth of the low wooded island-reefs in the Steamer Channel of the Great Barrier Reef is determined by slow "evolutionary" processes, and that heavily vegetated islands with an elaborate rampart system probably represent the more advanced stages of development, as suggested by Steers; Low Isles is now undoubtedly on the way to such a more advanced stage. On the other hand, the trend of such development is apparently not inexorable. It may be retarded or even reversed and, for reasons at present unknown, an island may revert to an earlier stage of development. A state of "balanced finality," to use Spender's expression, may only exist on parts of the island-reefs where constructive and destructive processes are in equilibrium over long periods. Many sand-cays are such features.

In this discussion we have made no reference to the influence of recent eustatic changes of sea-level to which study Steers has made such important contributions, because, as Steers himself recognized, the influence of such movements on the present structure of Low Isles is not obvious and a more general discussion of this question is beyond the scope of this paper.

Summary

The physiography of Low Isles has been systematically compared after a span of seventeen years, 1928–45, with the assistance of ground observation and air photographs of both dates. An opportunity for the comparative study of a coral island with such facilities is believed to be unique. The results of our work may be summarized as follows:

1. The shape of the reef platform maintains itself in the horse's hoof pattern with apex to the south-east, the Trade Wind direction, as already noticed by many authors. The total growth rate however, over the seventeen years in question, is almost unnoticeably slow.

2. The superficial veneer of rampart material is also controlled by this south-easterly wind influence, but is considerably modified by periodic north-easterly storms of cyclonic force. There is in consequence an asymmetrical development of multiple ramparts on the eastern side of the reef platform,

[1] 'The Snellius Expedition,' vol. 5, pt. 2.

thus providing shelter for the biggest growth of mangrove, which contributes further to the lack of balance in the otherwise symmetrical pattern of the "horse's hoof."

3. We believe that rampart development proceeds by accretion and continues with the gradual ageing of the reef. The older the reef, the greater the growth and number of ramparts. We recognized, not merely an Outer and Inner Rampart, but a succession of ramparts—1, 2, 3, and 4. The fourth, in fact, has been formed since the British Expedition was there in 1928–29. In addition, we attributed to even earlier ramparts certain sections of shingle material in the Mangrove Swamp which were too isolated to be correlated with each other as any particular stage.

4. We do not regard any tectonic or eustatic variation in the relative sea-level as necessary to explain the *growth* of ramparts. Well-marked benches were noted, as by earlier observers, on the adjacent mainland, but the question of correlating any such movement with the development of the Low Isles Reef Flat is at present left open.

5. The origin of high shingle-tongues, a feature of similar island reefs which are partly awash, not only in the north Queensland area but in the East Indies and elsewhere, is explained by the effect of a dominant wind direction on wave patterns "shepherding" the shingle debris in converging lines.

6. The action of acids in the Mangrove Swamp and Park in enabling the mangrove to "dig themselves in" has already been noted by Spender. Their importance appears to be greater than previously recognized and some consideration has been given to their nature. Further research seems to be needed on this subject.

7. Also requiring further investigation is the question of chemical solution of calcareous material by sea-water. Confirmation can be given to Kuenen's observation that it appears to be restricted to the inter-tidal zone.

8. We conclude that the Sand Cay is nothing but a large sand bank accumulated on the leeward side of the reef platform, and agree with Spender's conclusion that it is only maintained here by a nicely balanced equilibrium of forces of wind and wave. It is however protected to some extent from periodic disturbances of that equilibrium (such as cyclones) by the development of beach-rock which acts as a natural bulwark.

INDIA: MAIN POPULATION CONCENTRATIONS

LAWRENCE A. HOFFMAN

Summary

WITH 18 PER CENT. of the world's population living on 3 per cent. of the world's land area, India[1] is one of the earth's four major population concentrations, with an area and population equal to that of Europe (exclusive of the Soviet Union) or to that of agricultural China. It is as large in area as humid eastern United States, but has nearly four times the population.

India's average density of some 250 people per square mile is only moderately high, being less than the average densities of most western European countries or of such eastern Asiatic countries as Japan, Korea, the Philippines, or Java. However, those parts of India with level, moist alluvial soils have among the highest densities of population in the world.

About a third of India—mainly the Northern Plains and the Coastlands—has relatively excellent resources of level land, soil, and water and supports over two-thirds of the entire population. Another third of India—comprising chiefly the upland areas of the Indian Plateau—has moderately good resources of soil and water and supports most of the remaining third of the population. Only isolated spots in that third of India comprising the Highland Rim and the Thar desert are of much value or support more than a meagre population.

These great inequalities in the pattern of India's resources are relatively permanent and will probably always determine the main pattern of rural population distribution. Possible modifications through landscape alteration, drainage, irrigation, clearance, and the use of artificial fertilizers are relatively small, expensive, and generally most feasible in or near the fringes of the present population concentrations.

India is among the most rural of the larger countries, with 90 per cent. of the population living in some 658,000 villages and small towns. Only 10 per cent. of India's 390 millions live in the 1021 cities and towns of 10,000 inhabitants and over. With the development of a modern, integrated transport system, urban growth is tending to concentrate in the more accessible of the larger cities and towns. The 58 Indian cities (over 100,000) have more than two-fifths of the total urban population, while the seven largest conurbations have well over a fifth of that total.

India has ethnic, linguistic, religious, and social complexities similar to (some think even more complex than) those of medieval Europe before the standardization accompanying the era of modernization removed or diminished many local differences.

The cultural difference which has the most important present political implications is the communal one, particularly the tension between the Hindu community, which comprises two-thirds of the total population, and the Muslim community which comprises about a quarter. There is a consider-

[1] This paper was written in 1943, hence before the Partition. All statistical data were taken from the provincial volumes of the 1941 Census of India and from the 1940 Portuguese India and 1941 French India censuses.

able amount of areal concentration among the largest communities, nine-tenths of the Hindus, three-fifths of the Muslims, and two-fifths of the tribesmen living in districts where their respective communities formed the majority of the 1941 population. This should not obscure the fact that the intermingling of the various communities is widespread, and that the absolute numbers of communal minorities are tremendous. Some 25 million Hindus, 38 million Muslims, 16 million tribesmen, 6 million Christians, nearly 6 million Sikhs, over a million Jains, and about a million adherents of the smaller communities live either in districts where they are minorities or in districts where there are no absolute majority communities. These communal concentrations have changed but little in modern times, the most important change being the gradual disintegration of the tribal communities. Proselytism among the tribesmen has been chiefly in favour of the Hindu religion, secondly of the Christian faith.

Adapted from L. Dudley Stamp

Figure 1

The absolute increase in the Indian population during the past half century has been as great as the total population of humid eastern United States. Three-quarters of the increase has been concentrated in three distinct areas: in the two historic frontier marches (the Indus and Brahmaputra basins) and

in the eastern and southern parts of peninsular India. While the absolute increase in the Indian population has been tremendous, the rate of increase has been moderate, the average annual rate for the half century being only three-quarters of the world's average increase rate of about 1 per cent. Only during the past two decades has the Indian rate of increase been larger than the world rate, and nearly four-fifths of the total increase has occurred during that time.

Regional concentrations

Perhaps the simplest way to group information about India is in four major regions: the Highland Rim, the Northern Plains, and the Coastlands and Uplands of the Indian Plateau (Fig. 1). This regional system is adapted from that by Dudley Stamp, and is based partly on geological structure, partly on topography, partly on climate and soil, and partly on present human use.

Indian Regions: area and population, 1941 (Fig. 1)

Region	Area: Thousands of square miles	Area: Percentages of Indian area	Population: Number in millions	Population: Percentages of Indian population	Number per square mile	Regions of comparable area and population [1]
INDIA	1583	—	390	—	246	Europe; Agricultural China
HIGHLAND RIM	362	23	20	5	55	Barbary; Nigeria
Western Highlands	302	19	16	4	53	Afghanistan
Eastern Highlands	60	4	4	1	67	Syria-Lebanon
NORTHERN PLAINS	348	22	183	47	526	Yangtze Lowlands and Basins
Brahmaputra Valley	18	1	5	1	278	Formosa
Deltas Region	77	5	63	16	818	Honshu
Ganges Plains	127	8	82	21	646	North China Plains
Indus Plains	126	8	33	9	262	Manchurian Plains
Punjab part	92	6	29	8	315	Korea
Sind part	34	2	4	1	118	Ireland
INDIAN PLATEAU	873	55	187	48	214	Southern and Eastern Europe
COASTLANDS	196	12	78	20	398	Japan; Germany
Eastern Coastlands	94	6	45	12	478	United Kingdom
Northern part	34	2	17	5	500	Low Countries
Southern part	60	4	28	7	467	Kwangtung Plain
Western Coastlands	102	6	33	8	324	Poland
Northern part	66	4	14	3	212	Pannonian Plains
Southern part	36	2	19	5	528	Po Valley; Chekiang
UPLANDS	677	43	109	28	161	Eastern Europe
Thar Region	92	6	3	1	33	Yemen
Rajput Uplands	148	9	23	6	155	Spain
North-east Peninsular Uplands	229	15	39	10	170	France
Deccan Lavas Region	112	7	23	6	209	Indochina Coastland
Deccan Uplands	96	6	21	5	219	Yugoslavia

[1] It is not, of course, intended to imply that these regions are comparable in any other sense.

The Northern Plains are by far the most important region of India, and comprise the lowlands of the Indus, Ganges, and Brahmaputra river systems. These have about the same area as the Highland Rim but nine times the population, or the same population as the Indian Plateau on two-fifths of the area. The plains of the Indus have about the same area but only a fifth of the population of the Ganges–Brahmaputra plains. Nearly half of the entire population of India lives in these favoured lowlands, which together comprise a little over a fifth of the total area. Only one other region in the world has a comparable area and population—the Yangtze valley lowlands and basins, including Szechwan.

The contrasts between the Northern Plains and the Indian Plateau to the south are largely in surface configuration and soil. In many ways these contrasts are not so pronounced as those between, for example, north and south China or north and south Europe.

In terms of population-supporting capacity, there is considerable difference between the Coastlands of the Plateau and the Uplands. In having relatively favourable topography, soil, rainfall, and accessibility, the Coastlands are much like the Northern Plains. Nearly a fifth of the Indian population lives in these coastal strips, which comprise little more than a tenth of the total area. The Coastlands have an area and population similar to that of Japan or to that of pre-war Germany. Together, the Coastlands and the Northern Plains have two-thirds of the entire Indian population in only a third of the total area.

The Uplands of the Indian Plateau comprise the third major region of India. These upland areas have a larger aggregate population than the Coastlands, but their average density is only two-fifths as great. The Uplands are equal in area and population to Eastern Europe (between Germany and Italy on the west and the Soviet Union on the east). Certain alluvial valleys among the Uplands, and parts of the Deccan upland plains, carry as dense a population as the lowland plains. These Uplands, particularly along the eastern and north-eastern edges, hold most of India's known mineral wealth, especially her coal, iron, and ferro-alloy minerals.

Demographically, probably the least important of the major Indian regions is the Highland Rim which includes, generally speaking, all the northern highlands over 1000 feet in elevation. Although comprising nearly a quarter of the total area of India, these highlands support only a twentieth of the total population, and most of this is concentrated in a few valleys and basins adjacent to the Northern Plains. The southern part of the Western Coastlands (the Kerala and Konkan coasts) and the northern part of the Eastern Coastlands (the Northern Circars coast) each have about as many people as the entire Highland Rim, although each has only a tenth of its area.

Geographically, the importance of the Highland Rim lies in its influence on India's climate, for it shelters the country from the outblowing winter winds of the continental interior, it probably affects the system of monsoonal rainfall, and it provides orographic rainfall for the irrigation systems of the Indus Plains and the upper Ganges Plains.

Land-use concentrations

Nearly three-quarters of India's population is agricultural and, as with the rest of Monsoon Asia, it is mainly supported by intensive cultivation of the

larger river valleys and coastal plains. Consequently there is close correlation between heavy population densities and good cultivated land. Fig. 2 shows (in grey) population concentrations delimited by selecting all districts with average densities greater than the average 1941 density for India of 246 persons per square mile. These tremendous densities can be put in some perspective by recalling that, except in a few cases, the upper limit of

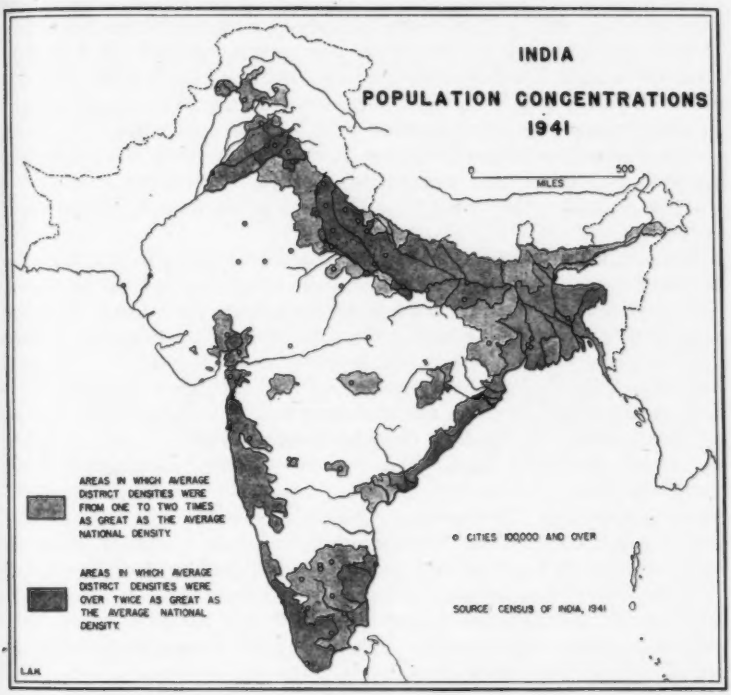
INDIA
POPULATION CONCENTRATIONS
1941
0
500
MILES
AREAS IN WHICH AVERAGE DISTRICT DENSITIES WERE FROM ONE TO TWO TIMES AS GREAT AS THE AVERAGE NATIONAL DENSITY
AREAS IN WHICH AVERAGE DISTRICT DENSITIES WERE OVER TWICE AS GREAT AS THE AVERAGE NATIONAL DENSITY
o CITIES 100,000 AND OVER
SOURCE CENSUS OF INDIA, 1941
0
L.A.M.

Figure 2

India : population concentrations in 1941, as delimited by average district densities

Category	*Area : Thousands of square miles*	*Percentages of Indian area*	*Population : Number in millions*	*Percentages of Indian population*	*Number per square mile*
INDIA . . .	1583	100	390	100	246
Both grey areas .	517	33	274	70	530
Lighter grey areas	276	18	95	24	344
Darker grey areas .	241	15	179	46	743
White areas . .	1066	67	116	30	109

predominantly rural densities in Europe is about 250 persons per square mile. No part of America has predominantly rural densities of similar magnitude. The average density of these areas (some 530 persons per square mile) is similar to that of Massachusetts or New Jersey, whose populations are, of course, mainly urban and industrial.

Even in the garden-type agriculture of the East, only those areas with level, moist, intensively cultivated alluvium will support population densities over 500 per square mile. Consequently the areas represented by the darker grey pattern on Fig. 2 have the bulk of the best agricultural land. Most of these areas are watered naturally, although supplementary and perennial irrigation are used, particularly in the drier north-western areas. The average density of the aggregate population in these areas is greater than that of Belgium, the most densely populated country in Europe. A measure of the tremendous aggregate population (nine-tenths rural) supported by these areas is the fact that it is as large as that of the main European industrial belt, on two-thirds of the area.

In India, areas of moderate population density, roughly from 250 to 500 persons per square mile, are generally areas of mixed good and mediocre land. The good land is generally of the same character as the densely inhabited areas already discussed, but occurs in smaller strips and patches interspersed with rougher, wooded, grassy, or swampy areas. Together, these areas (represented by the lighter grey pattern in Fig. 2) support a population as large as that of the American manufacturing belt, in a slightly smaller area.

The remaining two-thirds of India has average district densities less than the average density for India. While sparsely populated compared with the rest of the country, the average density of this area is as great as that of the American Corn Belt. The aggregate population is about as large as the population of Africa south of the Mediterranean littoral, in a tenth of the area. Fig. 2 obscures all but the gross pattern, of course, since much of the rougher and drier parts of these areas are practically uninhabited, while other parts are very densely or moderately densely populated. The humid and subhumid cultivated areas of the peninsular uplands support a population similar in density to that of the best areas of the American Middle West.

Urban concentrations

In any civilization the urban centres carry the genes of progress. Although only a tenth of India's population is urban, proportionately its influence is much greater, since it includes most Indians with modern political, economic, and social abilities, ideas, and techniques. For example, about a quarter of the Indian literates and a third of the Indian income are concentrated in the cities and towns.

While the proportion of Indian urban population is quite small, the absolute numbers of towns and town-dwellers are large. The 1023 Indian cities and towns of 10,000 inhabitants and over compare with 1077 cities and towns of similar size in America (1940), with 617 in Germany (1937 boundaries, 1939 data), or with 515 in Great Britain (1931). The 39·7 million Indian urban dwellers are fewer than the 62·7 million Americans in towns of similar size, but they are more numerous than the 35·7 million Germans, 36·5 million

Japanese, or 32·9 million British in their respective towns of similar size. Proportionately, of course, the 10 per cent. of the total Indian population in these towns is much less than the 48 per cent. of the American population, the 52 per cent. of the German population, the 50 per cent. of the Japanese population, or the 71 per cent. of the British population in their respective urban concentrations.

The small circles in Figs. 1, 2, 4, and 5 indicate the locations of the 58 Indian cities (over 100,000). Although these cities are only 6 per cent. of the

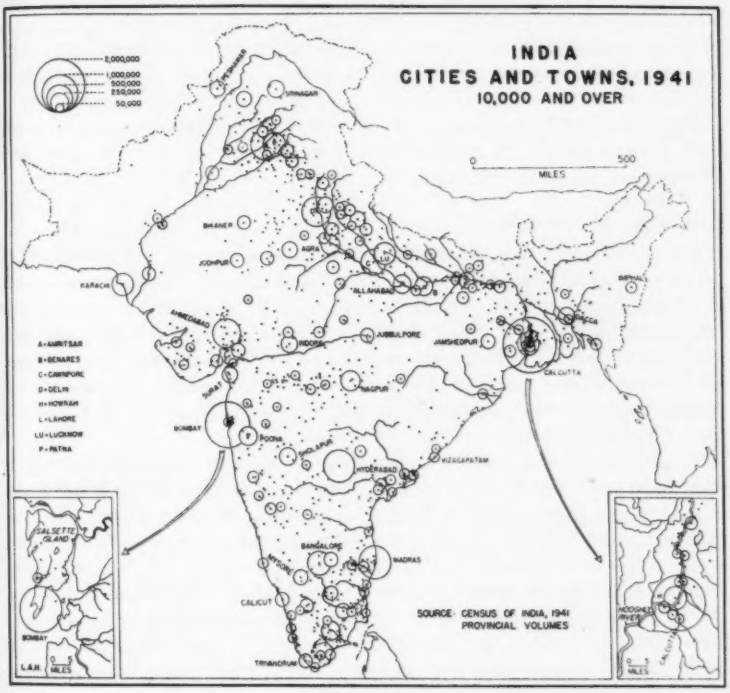

Figure 3

total number of Indian towns, they hold 42 per cent. (16·5 millions) of the total Indian urban population of 39·7 millions. The 97 large towns (between 50,000 and 100,000) have an aggregate population of 5·7 millions, or 14 per cent. of the total urban population. The smaller towns (between 10,000 and 50,000), numbering some 868, or 85 per cent. of the total number of towns, have only 17·4 million inhabitants, or 44 per cent. of the total urban population. In India, as in other lands, modern civilization is pre-eminently the product of the larger urban concentrations; the smaller towns are mainly market centres and are much less progressive.

Dwarfing the rest of the Indian cities and towns are seven conurbations with

over half a million inhabitants each. Together, these giants account for 22 per cent. (8·8 millions) of the total urban population.

The largest conurbation is Hooghlyside, the Calcutta metropolitan area (shown in the lower right-hand inset map of Fig. 3). As defined here, it includes 29 Bengal cities and towns and one French town (Chandernagore). These 30 towns and cities have an aggregate population of some 3·6 millions, or 9 per cent. of the total Indian urban population. Hooghlyside ranks about fourth among Asiatic urban concentrations.

The second largest Indian conurbation is the Bombay metropolitan area (shown in the lower left-hand inset map of Fig. 3). As defined here, it consists of Bombay city and 6 other towns on Salsette island. Together they have an aggregate population of 1·7 millions, or some 4 per cent. of the total urban population. In many ways, Bombay is more modernized than Calcutta.

With its suburbs, Madras has a population of over 0·8 million, while Hyderabad, Lahore, and Delhi metropolitan areas each has about 0·7 million, and Ahmedabad has some 0·6 million.

Communal concentrations

Fig. 4 shows that, when framed in district majorities, the concentrations of the largest Indian communities [1] present a fairly simple pattern. A huge block of Hindu districts occupies most of peninsular India and the greater part of the Ganges valley, while blocks of Muslim districts lie to the north-west and to the north-east of the Hindu block, and smaller tribal districts lie in extreme north-eastern India and in the north-western and north-eastern parts of peninsular India. Only in eastern Punjab and in the Bengal–Assam area are there many districts with no majority community.

The Hindu block of districts is huge, populous, overwhelmingly Hindu, and fairly sharply differentiated from the Muslim areas except in the Punjab and Bengal–Assam areas. Only in Bengal and Assam are there Hindu districts separated from the main block by non-Hindu areas. Perhaps the most significant fact about the Hindu block is that it holds 90 per cent. of the 256 million Hindus. It has 63 per cent. (992,000 square miles) of the total area of India, and 73 per cent. (285 millions) of the total Indian population, of which over four-fifths (231 millions) are Hindus. Well over three-quarters of the Hindus are in districts where their community is in the overwhelming majority (over 70 per cent. of the district population).

The most significant fact about the Muslim districts is their division into two blocks of unequal area but fairly equal populations. The larger, north-western block has almost nine-tenths (385,000 square miles) of the total area of the Muslim districts, and slightly less than half (35 millions) of the total population, with less than half (26 millions) of the Muslims in the whole group of Muslim districts. Together, the two Muslim blocks have 28 per cent. (435,000 square miles) of the total area of India and 20 per cent. (77 millions)

[1] The term "community" here refers to a socio-religious grouping and is roughly synonymous with the religion of the same name. There is one exception: the tribal community includes all the population still organized politically and socially on a primitive or tribal basis. Of the some 26 million Indian tribesmen, some 16 millions are Hindus, some 8 millions are Animists, about 1 million are Christians, and the remainder are mainly Muslims and Buddhists.

of the total Indian population, of which 74 per cent. (56 millions) are Muslims. About 60 per cent. of the 94 million Indian Muslims are in these Muslim districts; most of the other 40 per cent. (38 millions) are widely scattered over the northern and central parts of the Hindu block.

About two-fifths (10 millions) of the 26 million Indian tribesmen are in those districts where their community had majorities in 1941. The tribal districts do not form a solid block, but are split into numerous areas widely separated from each other. Together, these tribal areas form only 7 per cent.

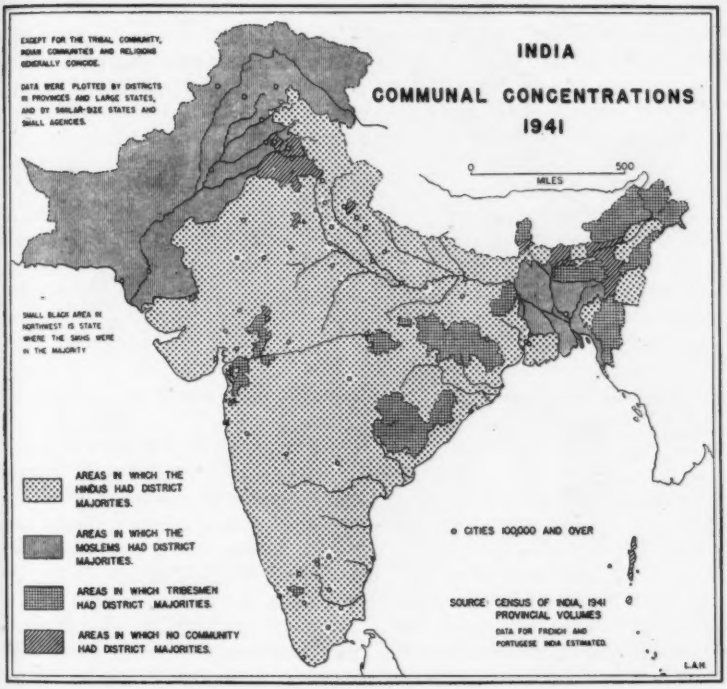
EXCEPT FOR THE TRIBAL COMMUNITY, INDIAN COMMUNITIES AND RELIGIONS GENERALLY COINCIDE.
DATA WERE PLOTTED BY DISTRICTS IN PROVINCES AND LARGE STATES, AND BY SIMILAR-SIZE STATES AND SMALL AGENCIES.
INDIA
COMMUNAL CONCENTRATIONS
1941
0
500
MILES
SMALL BLACK AREA IN NORTHWEST IS STATE WHERE THE SIKHS WERE IN THE MAJORITY
AREAS IN WHICH THE HINDUS HAD DISTRICT MAJORITIES.
AREAS IN WHICH THE MOSLEMS HAD DISTRICT MAJORITIES.
AREAS IN WHICH TRIBESMEN HAD DISTRICT MAJORITIES.
AREAS IN WHICH NO COMMUNITY HAD DISTRICT MAJORITIES.
CITIES 100,000 AND OVER
SOURCE: CENSUS OF INDIA, 1941 PROVINCIAL VOLUMES
DATA FOR FRENCH AND PORTUGESE INDIA ESTIMATED.
L.A.H.

Figure 4

(115,000 square miles) of the total area of India and have less than 4 per cent. (14 millions) of the total Indian population.

Only 2 per cent. (0·1 million) of nearly 6 million Sikhs are in the one small state which has a Sikh majority. The other Indian communities (Christian, 6·1 millions; Jain, 1·4 millions; Buddhist, 0·2 million; Parsee, 0·1 million; and others, 0·4 million) have no majority in any district, state, or agency of comparable size.

The average density of the total population in those Indian districts which have Hindu majorities is some 288 persons per square mile; that in Muslim districts is 176 (85 per square mile in the north-western block, and 860 in the north-eastern block); and that in the tribal districts is about 121. The one Sikh

district has an average density of 312 persons per square mile. The average density of population in those districts with no majority communities is 328.

Concentration of population increase

Within the present area of India, the absolute increase of population between 1891 and 1941 was over half again as large as that in the United States during

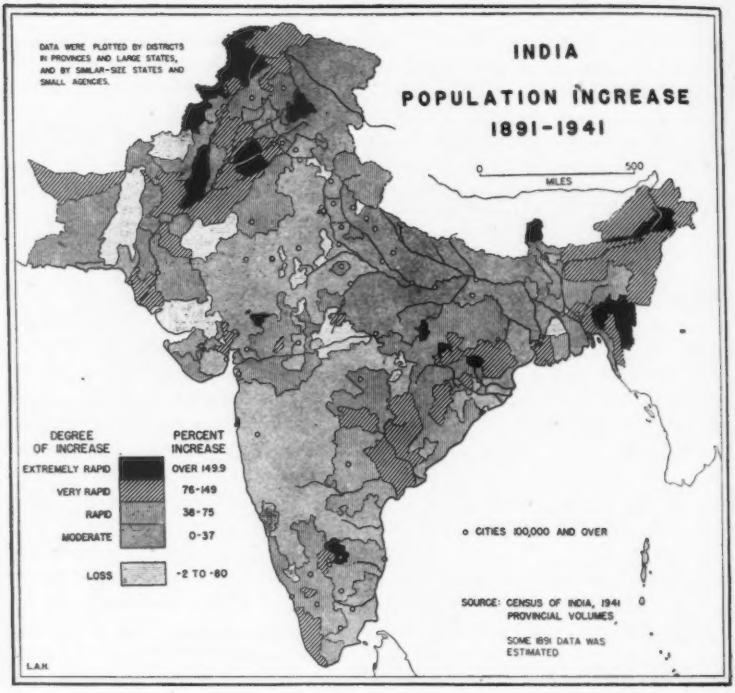

Figure 5

India: population increase, 1891–1941 (Fig. 5)

		Areas of increase				
	India	*Extremely rapid*	*Very rapid*	*Rapid*	*Moderate*	*Areas of decrease*
Area (thousands sq. miles)	1583	77	251	543	613	99
Percentage of total area	100	5	16	34	39	6
1891 population (millions)	283	4	28	80	162	9
Percentage of total population	100	2	10	28	57	3
1941 population (millions)	390	12	57	118	195	8
Percentage of total population	100	3	15	30	50	2
1891–1941 increase (millions)	107	8	29	38	33	−1
Percentage of total increase	100	7	27	36	31	−1
Percentage increase within category	38	200	104	48	20	−11

the same half century. Proportionately however, the 38 per cent. increase in the Indian population was moderate compared with the 109 per cent. increase in the American population.

Considering the Indian population as a whole, the decennial rates of increase varied considerably during the period, nearly four-fifths of the absolute increase of 107 millions occurring in the last two decades. The first and third decades showed meagre increases of 1 per cent. each; the second decade showed an increase of 6 per cent.; the fourth, 11 per cent.; and the fifth, 15 per cent. In contrast, the decennial rates of increase in the American population during the same period were 21 per cent. during each of the first two decades; 15 per cent. during the third; 16 per cent. during the fourth; and 7 per cent. during the fifth decade. The Indian rates of increase were those of a population which had little voluntary control over its own numbers, while the American rates of increase were those of a population which was gaining considerable control over its own growth during the period.

As Fig. 5 indicates, the Indian population increase has been concentrated in area as well as in time. Most of the areal concentrations were supported by increases in the amount of cultivated land, generally through drainage or irrigation of former wasteland or pasture.

A quarter of the total increase took place in the Brahmaputra valley and neighbouring highlands, and was supported by a large increase in the cultivated acreage, mainly through drainage and clearance of swampy wasteland. Most of the population increase was the result of natural increase among the Bengali, but some was contributed by natural increase among the Assamese hillsmen, and some by immigration from the Ganges valley and parts of peninsular India—for example, from the United Provinces, Bihar, and Central Provinces to the tea plantations.

The large-scale irrigation projects of north-western India have attracted much more attention than the drainage and clearance projects of north-eastern India, but their relative contribution to the population-supporting capacity of the country in the past half century has been only a little over half.

The population increase in the eastern and southern parts of peninsular India has been slightly greater than in Bengal–Assam but distributed over an area nearly twice as large. Here too, cultivated area has been added to by irrigation and drainage projects, and in the south by the introduction of crops tolerant of the sandy, infertile soils of the interfluvial areas (for example, peanuts). Natural increase among the tribesmen and the lower-caste Hindus accounts for much of the increase. Most of the increase in these areas has been among Dravidian-speaking people, in contrast to the northwestern and northeastern areas where the increase has been chiefly among Indo-European speakers.

Postscript

Since this article was written in mid-1943, wartime and postwar population changes have altered some of the 1941 concentrations discussed above although they remain substantially the same. The facts that the present population may be some 415 millions, or 25 millions greater than in 1941, and that the present urban population is apparently both absolutely and relatively slightly greater

than it then was, are less striking than the further fact that there have been additional communal concentrations, especially in the Punjab.

Western Pakistan (excluding Jammu-Kashmir) is now almost wholly Muslim, as a result of the emigration of some 5 million Hindus and Sikhs to the Indian Union and the immigration of over 6 million Muslims from east Punjab and adjacent areas. The Muslims now form perhaps 97 per cent. of the total population as compared with 79 per cent. in 1941. The east Punjab areas, shown in Fig. 4 as having no majority community, together with Kapurthala State and the Indian Union portion of Gurdaspur district are now almost entirely Hindu and Sikh. The 6 million Sikhs are now mainly in east Punjab although their detailed concentration is somewhat obscure.

The Bengal communal pattern is substantially the same as in 1941, although the emigration of a reported 1 to 2 million Hindus from the area may have raised the 1941 Muslim majority of 70 per cent. in Eastern Pakistan to a present majority of some 75 per cent., and may have eliminated the small 1941 Hindu majority of 51 per cent. in Khulna district.

Little is known definitely about the present communal concentrations in disputed Jammu and Kashmir State. In 1941 some 77 per cent. of the 4 million inhabitants were Muslims (Jammu division 61 per cent.; Kashmir division 93 per cent.; Frontier Districts 87 per cent.). If the reported numbers of refugees exchanged are correct, it is just possible that Jammu division now has a Hindu majority.

The Muslims in Hyderabad State, who numbered 2·1 millions in 1941 (13 per cent. of the total population of some 16·3 millions), are reported now to number about 2·5 millions, part of the increase being due to natural increase, part to an influx of Muslim refugees.

No official data for the small Portuguese and French colonies are available. Probably about two-thirds of the Portuguese India and about nine-tenths of the French India populations are Hindus.

The population of the Indian Union (excluding Jammu–Kashmir and Hyderabad States) is now about 80 per cent. Hindu, about 12 per cent. Muslim, and about 2 per cent. each animist tribesmen, Christians, Sikhs, and others. Of the approximate 285 million Hindus in the world, about 85 per cent. are in the Indian Union, about 5 per cent. each are in Eastern Pakistan and Hyderabad, about 2 per cent. are in Nepal, and the remainder are scattered widely.

A first analysis of the effects of the Partition is given in O. H. K. Spate, "The partition of India and the prospects of Pakistan," *Geogr. Review* 38 (1948) 5–29. Also useful are A. Geddes' studies of population change, "Half a century of population trends in India," *Geogr. J.* 98 (1941) 228–53, and "The population of India," *Geogr. Review* 32 (1942) 562–73.

ENGLAND OF THE GLORIOUS REVOLUTION

THE JOURNEYS OF CELIA FIENNES. Edited and with an introduction by Christopher Morris. With a foreword by G. M. Trevelyan. *London: Cresset Press*, 1947. 8×5 *inches*; xlv+376 *pages*; *sketch-maps*. 8*s* 6*d*

MISS CELIA FIENNES requires no introduction to those geographers who are familiar with the studies of seventeenth century England which we owe to Mr. J. N. L. Baker. It was he who aroused our interest in a little book entitled 'Through England on a Side-saddle in the time of William and Mary,' which was published sixty years ago and has long been out of print. The horse-woman was Miss Fiennes. The charming record of her journeys was originally intended for the delight and instruction of the drawing-room, but a changing outlook among scholars has carried it into the study. As a natural consequence a new edition was called for, textually accurate and complete, equipped with the apparatus of notes and introduction that learned readers find indispensable. The Master of Trinity relates the history as it affected him personally in a brief foreword: "I have always regarded it as a fascinating book in which to browse, and I have increasingly thought of it and used it as a valuable source of economic and social history, in the same class as Defoe's 'Tour' of a few years later. But, both for pleasure and for historical use, a proper edition, with scholarly notes and introduction, was eminently desirable. And at last we have got it." How surprised Miss Fiennes would be! For although she thought her narrative would prove "diverting and profitable" to members of her own sex, she hastens to add "tho' not to Gentlemen" who have "more opportunity to be informed" than the Ladies.

Miss Celia herself was a Nonconformist and Whiggish lady of high birth (she makes great play with "my grandfather Saye and Sele" the notable Roundhead Viscount) with a remarkable gift for freely speaking her mind. After her mother died, and when she was in her middle thirties, she was advised by her physician that open air and exercise would benefit her health. She decided to go a-riding, and travelled the length and breadth of England, often quite alone save for a couple of man-servants. The remedy was effective, for she died (still unmarried) in 1741, a redoubtable old lady of seventy-nine. The record of her travels was written down in the first year of the reign of Queen Anne, and included besides what she termed her "great" journeys, from Land's End to the Scottish Border, a very large number of shorter excursions, either drives with her mother to visit relations, or sight-seeing tours round and about her relatives' mansions. Both her father's and her mother's families were large ones, while the circle was extended by the marriages of her own brothers and sisters. No family connection seems to have been too remote for hospitality to be offered or at least claimed. Even so however Miss Celia was continually under the necessity of putting up at inns and only on two or three occasions did she fail to find such accommodation, when she had to fall back upon a poor cottage or on the kindness of strange gentry. It was from the inns that she obtained most of her information, for it was her regular custom after supper to sit down for a comfortable chat with the landlady and satisfy her intelligent curiosity about the neighbourhood and its people. Only once (or so we may infer) did this method fail her, at Carlisle, where was "a young, giddy landlady that could only dress fine and entertain the soldiers." But there was consolation at Truro where "my greatest pleasure was

the good Landlady I had; she was but an ordinary plaine woman, but she was as understanding in the best things as most, the experience of reall religion and her quiet submission and resignation to the will of God in all things, especially in the placing her in a remoteness." It was because all her information was collected by word of mouth that Miss Fiennes writes so freshly and vividly, although as a consequence she spelt unknown words and place-names as she heard them pronounced. Her "canelles" for example are the "goonhillies," the little hardy Cornish horses called after the Downs near the Lizard where they pastured on the furze.

In person Miss Fiennes was short and slight, as may be inferred from certain passages and incidents which the reader may find for himself. And she was completely tireless. Never a tower, or a leaded roof, or a hill-top but she must climb it to view the prospect and to note whether the fields were champion (open) or enclosed. Never a well or spring, even if of "stinking" quality, but she must taste it and take up some of the water in her hands, while she made nothing of going down sixty steps into one of Nottingham's famous cellars, fortunately finding an excellent beer at the bottom. In the same city she tried her hand at spinning glass and watched the workman fashion a swan. For every sort of industrial activity fascinated her, whether it was tin-mining, or cloth-making, or salt-working, or simply the household preparation of oat-cakes or "clap bread." Her interest in trade and manufacture was typical of the Whigs and Dissenters of her circle, and she shared their belief that poverty was the result of laziness and imprudence, while the industrious and prudent man naturally became rich. Thus when she made a brief excursion into Wales she noted that "the inhabitants go barefoote and bare leg'd, a nasty sort of people," while she comments very severely upon the extreme poverty she observed in the Lake District and just across the Scottish Border, "which I impute to their sloth." On the other hand, she was delighted with districts like Leeds, East Anglia, and Exeter, where, owing of course to the combination of a prosperous agriculture and an expanding manufacture, there was on all sides bustle and vigour and abundance. In his famous analysis of the composition of the English population by classes, which refers to this very period, Gregory King brackets cottagers with paupers, and Dr. Charles Davenant, making use of his tables, is doubtful whether to include the cottagers as increasing or actually decreasing the wealth of the Kingdom. But in the textile areas where the women and girls sat spinning at their doors, or making lace, or where the men were carrying yarn back to the loom, the cottagers were certainly productive. It appears even possible that Celia Fiennes was a reader of Davenant's famous 'Essays,' for his stress on the people as the source of a country's power and wealth, and on the need to ponder their numbers "and quality" is echoed in a passage in which she urges that, valuable as travel and observation might be to Ladies as a cure for the Vapours, yet "much more requisite is it for Gentlemen in general service of their country at home or abroad, in town or country, especially those that serve in Parliament, to know and inform themselves the nature of Land, the Genius of the Inhabitants, so as to promote and improve Manufacture & Trade suitable to each, and encourage all projects tending thereto."

Numerous are the topics upon which this keen-sighted and intelligent lady throws light, giving us in sum a strong impression of the regional differences and contrasts in modes of life throughout the United Kingdom. Crops interest her because she does not enjoy eating oat-cakes or rye-bread, and is vexed if her horses cannot have their accustomed generous fodder. As to fuel, she notes the cow-dung drying on the cottage walls in East Anglia and the East Midlands, but that, fortunately, was only for use of the poor. In Cornwall however she

observed her supper cooking over a fire of the cottager's furze, and asking why, was told that it was "because of the War." French pirates had been active round about Land's End and the colliers from Bristol and South Wales refused to risk entering the Channel. Sea coal she saw elsewhere being transferred from barges to trains of pack-horses at the head of navigation, and noted with housewifely concern how rapidly the price rose with this method of carriage since each animal's load was no more than a couple of bushels. Yet, if she is correct, every village blacksmith made use of coal and it was the normal fuel at the inns and in the large towns. Near the inland coal-fields it was, of course, very cheap. Miss Fiennes often stayed with relatives near Cannock Chase, and there she found that a cottager could have a load of cannel coal (giving light as well as heat) delivered to his door for three or four shillings (presumably by cart), whereas in London the same load would cost her forty shillings. When she lodged in Ely her upstairs chamber was warmed by faggots, out of which, she declares, came slow-worms, frogs, and snails. Ely indeed was "the dirtyest place I ever saw," the streets "for want of pitching (*i.e.* paving) only a harbour to breed and nest vermin in." That may have been true, but we may suspect some prejudice. For the caretaker of the Cathedral revealed to her that in James II's time the Papists "hoped quickly to be in possession of it . . . but blessed be to God that put a tymely stop to the Protestants' utter ruin and the hopes of the Papists," comments the Dissenting Celia.

But Ely was exceptional. In most of the towns she could praise the clean, well-paved main streets and spacious market-places, while even on the country roads her complaints are not so great as might be expected. This was probably because over the worst sections she was usually able to ride along the "causey," that is to say the narrow paved way beside the road which was made increasingly necessary by the expansion of pack-horse traffic. A pavement is still called a causey in the Midlands. This of course did not solve the problem for coaches and carts, and we find that well over a score of Acts of Parliament for the amending of particular stretches of highway were placed upon the Statute Book during the reigns of William III and Anne. These, as might be expected, usually refer to the road sections across the heavy clays. Incidentally, Miss Fiennes saw the beginning of sign-posting, although on occasion she had to employ guides. In Cornwall the roads were often little more than narrow rocky tracks, over which wheeled traffic was impossible, and farm produce was carried on the backs of the little horses which often almost completely disappeared under a great load of hay or straw. It is of interest to read Celia Fiennes' travels with a copy of Ogilby's road-maps at hand, for whether she follows a highway, a principal cross-road, or a road which Ogilby omits, her descriptive detail affords means of checking the accuracy of his maps and discounting the false ideas of easy travel which they tend to suggest. Two little sketch-maps are supplied by the editor but they do no more than furnish a general picture of the parts of the country which this intrepid horsewoman covered, seemingly with complete disregard of wind and weather. She had several narrow escapes of being heavily thrown, but she believed firmly that a special Providence watched over her, and that it was this rather than some sharp work with the whip that made her horse recover from a stumble.

Space does not permit of more than a bare mention of Miss Fiennes' minute investigation of the gardens and interiors (whether she knew the owners or not) of the larger "gentlemen's seats" that lay on her route. Especially was she interested in the arrangements and furnishings of the principal bed-chambers above stairs, and she was only satisfied if adjoining dressing-rooms or dressing-closets, maid's room, and back-staircase approach ensured My Lady's comfort.

With great delicacy of language she describes the water-sanitation in the Royal Apartments at Windsor, and indeed her language and style (although but for the editor's inserted commas she much resembles the immortal Miss Bates in breathlessness) are not the least of the many charms of her narrative.

E. G. R. TAYLOR

A GERMAN VIEW OF GEOPOLITICS

THE FIRST VOLUME of the new German periodical, *Erdkunde: Archiv für wissenschaftliche Geographie*, contains a long paper by Professor C. Troll on geographical science in Germany from 1933 to 1935. This includes a section on geopolitics which is summarized in the following paragraphs without comment, or necessarily accepting all the arguments. The sub-title, "the tragedy of a doctrine and of a family," indicates the general line of treatment.

The writer includes geopolitics in his survey because this controversial branch of science was very closely related to geography, though it was never recognized as a geographical discipline and was sharply differentiated from political geography. This new subject evolved very rapidly, so that criticism must be coordinated with the stages of its development. These were its formal naming and definition by the Swede, R. Kjellén, during the first world war; its extension as an "applied science" by K. Haushofer from 1924; its incorporation in National Socialist policy after 1931; and finally its rôle in the second world war as an instrument of politico-military training in morale.

The appearance of the *Zeitschrift für Geopolitik* in 1924 may be taken as the real beginning of geopolitics. While Kjellén called it "a science which treats of the State as a geographical organism or a spatial phenomenon," Haushofer wished to make it an application of geography to politics requiring not only knowledge but art—"the ways which lead from the strong but rather static scientific citadel of political geography to the dynamic art of geopolitics." The theory that the concept of political geography is static, while that of geopolitics is dynamic, met with a response from geographers (Lautensach, Mortensen, Schrepfer). Haushofer's personality, on the one hand exerting itself through his encyclopaedic and up-to-date knowledge, his eloquence, and his amiability, on the other hand completely lacking in strict scientific logic, exercised a very varied influence on his contemporaries. Appealing simultaneously to sentiment, taste, and intellect, he had great influence on the educated public, among poets and artists, business men and politicians, and above all among journalists, even beyond the frontiers of Germany. He skilfully embellished his opinions on man, culture, and State with a certain oriental mysticism, so that he could support them by his experiences in Japan and his journeys in other Asiatic countries. In scientific circles however, criticism and dissent predominated. His limited following was supported against "narrow-minded scholarship" by the lively, many-sided, world-embracing personality of the master, and by the national aims which he pursued through geopolitics. At this time also his two sons, men of notable scientific and intellectual capabilities, were entering on their careers: one of them, Albrecht, as a geographer and student of politics, having close associations with the outside world. Thus from 1924 Haushofer attracted a series of colleagues from among scientific geographers—O. Maull, E. Obst, N. Lautensach, K. Sapper, F. Termer, H. Hassinger and other scholars, who

seemed to assure the sound development of geopolitics. Unfortunately in a few years, through his journalistic and commercial instincts, Haushofer gained many new supporters for his pseudo-science from the younger generation and from semi-scientific circles, and honest criticism could no longer prevail. To his own works ('Geopolitik des Pazifischen Ozeans,' 1924; 'Grenzen,' 1927; 'Geopolitik der Panideen,' 1931) and those of his co-worker, O. Maull ('Baustein zur Geopolitik,' 1928; 'Die Grossmächte vor und nach dem Weltkrieg,' 1928) were added geopolitical works which foreshadowed political dangers.

Scientific criticism had to be conducted with care in those days, but many of those capable and perhaps ready to exercise it, refrained, partly out of regard for the courteous Haushofer, but partly also in the belief that he, through his pupil Rudolf Hess, might avert many political dangers and exercise a beneficent influence, as in fact he had often attempted to do in the early years of the Third Reich, and often successfully.

The first fundamental attack on geopolitics, apart from an earlier assault from the Marxist side, came from the French geographers, A. Demangeon and J. Ancel. German geographers accepted their criticisms in principle, but regretted that the attack was directed upon German geography as a whole. Political geographers free from the delusions of geopolitics (W. Vogel, A. Supan, H. Hassinger, R. Sieger, and others) were completely overlooked, though Demangeon gave some praise to the works of E. Obst and O. Maull. Down to 1931 the faults of Haushofer's geopolitics were lack of scientific method, a political trend not always based on facts, a striving for effect through the use of new slogans ("Zerrungsräume," "Lebensraumenge," etc.) and trick sketches which expressed complicated space relations by simple arrows. Purely political comments also increased in the *Zeitschrift*. According to E. Obst's later avowal (1935) it was only the need, in the circumstances of the times, to place science at the service of the State and of politics which led German geographers, under Haushofer's leadership, to secure a place for geopolitics in Germany, despite the derision of many colleagues.

Before the rise of the Third Reich, also, an important change had occurred—the foundation in 1931 of an "Arbeitsgemeinschaft für Geopolitik." This exerted increasing influence on the *Zeitschrift*, particularly through its publisher, K. Vorwinckel, a very active member of the "Arbeitsgemeinschaft." The policy became pronouncedly National Socialist. Geopolitics was regarded not as a branch of science but as "a fundamental principle and an inner attitude," drawing its content from history, geography, and biology. The demand was made that in the schools history and geography should be merged into geopolitics, and that the whole economic organization should be subject to its theories. The study of population was also subordinated to them, and Party racial theories, which Haushofer for well-known reasons had previously excluded, were incorporated. During these years it is significant that early collaborators in the *Zeitschrift*, the three well-known geographers, H. Lautensach, O. Maull, and E. Obst, withdrew their support. After the seizure of power by the National Socialists, the new ideas appeared more undisguisedly in the *Zeitschrift*, and the adoption of geopolitics by the Party obliged geographers with public appointments to come to terms with it. At a meeting of the "Arbeitsgemeinschaft" at Bad Saarow in May 1935, organized in conjunction with the Central Institute for Education, the place of geopolitics in schools was discussed. Haushofer defended geopolitics in person, under the slogan "Blut und Boden" though admitting that examination of young university students of geopolitics had revealed a catastrophic intellectual condition. H. Mortensen set out the geographical criticisms, but proclaimed a salutary cooperation between geopolitics

and geography. The meeting accepted the demand for geopolitical instruction in the schools, as a link between the various subjects bearing on it. Thus, once again, it was recognized that geopolitics was not a separate subject and was not identical with political geography.

Another pronouncement was made in the *Zeitschrift* during 1936, the editor, H. Schrepfer, standing out against the changes of interpretation introduced by the "Arbeitsgemeinschaft," and Haushofer adopting an ambiguous attitude. This debate had arisen from a domestic quarrel in the "Arbeitsgemeinschaft" between Vorwinckel and Gehl and the geopolitician R. Hennig on the position of racial theories in geopolitics. It is interesting to note that the charge of "geographical determinism," which had been brought a few years earlier, on sound historical and economic grounds, against geopolitics and its disciples by the Marxist school, was now levelled at the veteran geopolitician Hennig by the racial theorists of the "Arbeitsgemeinschaft." In this year Vorwinckel could boast that geopolitics had stood by the National Socialist revolution from the beginning, and warn his intellectual opponents of decisive action against developments irreconcilable with the Party outlook. Thus the last traces of science and open discussion were thrown aside, and control passed from Karl and Albrecht Haushofer.

At the same time geopolitics ceased merely to be a general intellectual danger and became a direct threat to the nation, for in 1932 "Wehrgeopolitik" was founded, the outline of which came from Haushofer's pen. This can be described only as an abuse of science. How uncritically it was employed by amateurs and how rapidly their pseudo-scientific "intuitions" could become ridiculous may be gathered from a commentary published in the *Zeitschrift* shortly after the outbreak of the war with Russia. There the conclusion was reached that the occupation of Europe to the Urals was no more difficult for Hitler than the advance to the Rhine was for Napoleon. Such were the results produced by the "Arbeitsgemeinschaft" after ten years' work. Its foundation was perhaps the most decisive event in the history of geopolitics. With the admission of unscientific and tendencious publicists to the pages of the *Zeitschrift*, Haushofer abandoned, apparently unwillingly, the guidance of his geopolitics and severed the connection with pure science which he had carefully preserved before 1930. It so happened that his son Albrecht, general secretary of the Berlin Geographical Society, sought, under the influence of Albrecht Penck, to enter the field of physical geography, but finding his peculiar talents unsuited for this, remained isolated from pure science. Thus the tragedy of geopolitics coincided with the tragedy of the Haushofer family. The father sought belatedly to adjust himself between two opposing worlds. With greater perspicacity, the son saw the approaching downfall of the fatherland. The influence of the family on the Party, which had been important, declined after 1938, and particularly after Hess's flight to England. Albrecht separated from his father, and, longing with other patriots for the rescue of his country from complete ruin, met a tragic but honourable death as a prisoner of the Gestapo. His masterly poems written in prison, "Moabiter Sonette," are a moving document of his tragic end. To the father also, who later committed suicide, one cannot refuse the verdict of a tragic destiny. He was, it is true, no scholar and no professor in the usual sense, but an individual of intelligence, culture, and ability who in other circumstances might have accomplished better things.

Haushofer's political influence was greatly overrated in foreign countries during the war. This mainly arose from the supposition that the Ribbentrop–Molotov agreement of August 1939 was "a triumph of the master of geopolitics over the anti-Russian clique of A. Rosenberg," and that this agreement was the

result of the great influence of Sir Halford Mackinder's ideas upon Haushofer. The erroneousness of this conjunction was pointed out by Strausz-Hupé as early as 1942. The story of the "roomy and luxurious headquarters of the Institute of Geopolitics" in Munich, which linked it to the Deutsche Akademie, is also a misconception. In fact no geopolitical institute ever existed in Munich, either in the Academy or the University. K. Haushofer never once received a "venia legendi" for geopolitics in the University. The idea could easily have sprung from his many-sided activity. It is true however that in 1941, on the foundation of the "Auslandswissenchaftlichen Fakultät" in the University of Berlin, Albrecht Haushofer was appointed head of a small "Institüt für Geopolitik" within it.

Completeness and justice require an examination not only of the results of geopolitics, but of the sources from which it drew its material. Wittfogel and Stausz-Hupé have already done this in detail, but both from specialized points of view, Wittfogel from that of Marx's materialistic interpretation of history, in a critical examination of the materialist economic and social theories and the geography of the nineteenth century, Strausz-Hupé in an outspoken attack upon German nationalism, regarding geopolitics as the last manifestation of this ('Geopolitics: the struggle for space and power,' New York, 1942). Wittfogel went back to Montesquieu and G. von Herder, "the prophet of the geographical-materialistic philosophy of history." Strausz-Hupé saw the beginning of the disease in the political strategy of D. H. von Bülow (1799), and traced the culprits from Ritter, von Treitschke, List, to Ratzel and Kjellén. In fact however, geopolitics was rooted in nineteenth-century theories on the relations between man and nature, and on the dependence of economic life and social structure upon the environment. This was not a specifically German development, but an intellectual movement common to all Western Europe. One may compare it to the factual treatment of these questions in the book by the Swiss economic geographer P. H. Schmidt, or with the point of view of the Dutch school of social geography under van Vuuren.

Geopolitics derives, as Haushofer always insisted, directly from Ratzel and his theories of movement. But Ratzel was not an isolated figure. He grew up with the neo-naturalism and positivism which developed from the evolutionary theories of the great biologists Lamarck and Darwin. In the sphere of biology these led to the monism of E. Haeckel. But two West European thinkers, August Comte, the founder of sociology, and Herbert Spencer, transferred them to social life, in which they saw social phenomena as the creation not of the human spirit but of the biological organic world. In the transference of these theories from biology to sociology lies the origin of Ratzel's theories and of the predominance of the environment in earlier geographical thought. Only with difficulty can Ratzel be held responsible for the use made later of his ethnography and anthropo-geography. As Ratzel in his triune of 'Space, position, movement' emphasized the rôle of movement, he supplied the foundation for "the dynamic art of geopolitics," but when the geopolitician refers to the State as an organism, this can be with equal justification traced back to Comte. Ratzel in his time was not solely a German: he exercised a strong influence on foreign geography, in France (Vidal de la Blache, Brunhes), in the United States (the environmentalism of E. C. Semple), and elsewhere, more decisively in fact than in Germany itself. While for some decades in Germany anthropogeography was mainly concentrated on historical development, French "géographie humaine" began to trace out the social and economic themes, and to emphasize the "genre de vie." The claim made for geography by Wittfogel, that it must view the relations between man and nature not only in the light of a

passive naturalism but also as functional ("aktivistisch") in the evolution of the social organization and the processes of labour, was meanwhile fully accepted by German geographers. G. R. CRONE

CANADA: A STUDY OF HUMAN ENVIRONMENT

CANADA: a study of cool, continental environments and their effect on British and French settlement. By GRIFFITH TAYLOR. *London: Methuen*, 1947. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* xv+524 *pages; maps and illustrations.* 25*s*

FEW GEOGRAPHERS OF this generation are likely to surpass Griffith Taylor in prodigality of output or in fertility of ideas. 'Canada' is the third full-length work to come from his publishers within a twelvemonth, and the thirtieth in as many years. It is certainly one of the most stimulating, though not, in our view, one of the most satisfactory. It should be read with gratitude—for it is the first exhaustive survey of Canada in the English language—but also with discrimination. Ardent determinist that he is, Dr. Taylor is sometimes apt to credit his theories with an authority not supplied by the facts, and there are occasions when the facts themselves are not above challenge.

The reader's critical faculty is called into play very early on, since the author even injects a note of controversy into his list of contents. Here we learn that after dealing in Part 1 with exploration, structure, climate, and soils, the author will proceed in Part 2 to divide the Dominion into a number of "natural regions" classified surprisingly under the four headings "Populous," "Transition," "Pioneer," and "Tundra" lands. Our suspicions that he is straying from the path of Herbertsonian orthodoxy are confirmed when we read later that he will consider "the human aspect" of the natural regions as well as the purely physical. This consideration proves to be detailed enough to merit the sub-heading "Environments as related to man," a title which Dr. Taylor reserves however for the third section of the work dealing with the distribution of population and economic activities throughout the country.

Chapter 1 does little to remove the grounds for our disquiet. By way of giving us "a very fair idea of the topography and resources of occupied Canada," Dr. Taylor chooses seven localities (grab-sample fashion) situated equidistantly between the Atlantic and Pacific seaboards, and describes their essential characteristics with the help of photographs. Three of the seven, namely, Val Morin, P.Q., Kapuskasing and Kenora in Ontario, fall within the confines of a single structural unit. The other four are Lunenburg, N.S., Riverside, Sask., Banff, Alta., and Vancouver, B.C. It will be seen therefore that the two most important occupied regions—the St. Lawrence Lowlands and Lower Ontario, which between them have some 75 per cent. of the population of the Dominion and an even higher proportion of its industries—are without representation. We find the author's choice of localities and their limitation to seven all the more curious when we subsequently read (p. 113) that his experience has led him to "the conclusion that a total of about twenty units is advisable" when attempting a regional interpretation of Canada. And we are still wondering why he took his traverse along a curved line; it is true that all seven localities appear from the

map (p. 6) to lie on a straight line, at regular intervals of 450 miles—but it does not happen to be a parallel of latitude or even part of a great circle!

Dr. Taylor's map of natural regions (p. 114) is equally open to question. Leaving aside the propriety or otherwise of employing the term "natural" in this context, it is surely flying in the face of facts to call the north shore of Superior and the middle Fraser regions "populous." A moment's glance at the official population map (which Dr. Taylor reproduces on p. 496) will suffice to show that these areas are much emptier than the so-called "transition regions" of Newfoundland, the Clay Belt, and the Peace River, which by definition are said to be less important demographically than the "populous" regions. Then again, to those of us who have been taught to think of pioneer regions as areas of real promise lying along the margins of closely settled agricultural land, it is disconcerting to see northern Labrador, northern Quebec, the southern shores of Hudson Bay, and northern Manitoba given this classification.

The reason for his self-styled "Utopian optimism" is disclosed in Chapters 4 and 20. Here we learn that the northern boundary of the "pioneer" regions has been drawn to coincide roughly with the run of the 57° July isotherm. This isotherm sets the lower limit of successful root-crop cultivation and the inference is drawn (p. 515) that this limit in turn defines the likely northern edge of "notable settlement." While allowing the feasibility of this argument, we venture to doubt whether a diet of mangolds, turnips, and potatoes won from a reluctant soil, frost-bound all the year (and so ill drained), low in humus and organic compounds, would ever constitute much of an attraction to intending settlers. That the author himself has reservations on this point is suggested by the fact that in the course of the book he uses no less than four isotherms to demarcate the poleward limit of agricultural settlement, namely the 56°, the 57°, and the 59° July isotherms, and the 57° summer isotherm; and the positions accorded to these are anything but stable (compare, in this connection, Figs. 21, 79, and 120).

Similar inconsistencies occur elsewhere. Thus spring is said in one place to have begun when the mean temperature reaches 42° F.; in another place the 43° F. isotherm is cited. Again, the term "marine climate" is very loosely employed. On p. 59 the Maritimes and Vancouver area are both credited with a "marine climate," yet on pp. 78–9 the author quotes, with approval, Köppen's climatic classification which places the Maritimes in the category of "continental forest climate with a severe winter" and Vancouver in "a moderate marine forest climate with mild winter."

More serious objections must be raised against the meteorological section of the book. The author is obviously not at home with the air-mass concept. The block diagram portraying the air-mass situation over North America on 9 June 1928 is a grievous distortion of the facts; so too is the statement (pp. 63–4) that "the whole mechanism [of air-mass movement] reminds one of a circus merry-go-round where the horses bob up and down, while the whole apparatus rotates around the central pole of the tent" (which he identifies with the North Pole). Air masses are no more given to "bobbing up and down" than are ocean currents, and in so far as they rotate, they show more affinity for the magnetic pole than the terrestrial. Nor are we happy about the confusion between polar front and cold front (p. 64), or the statement that cold waves occur only when a depression halts in its progress to the east; and it is far from the truth to say that a heavy snowfall can only occur when the temperature is below 32° F.

Dr. Taylor is much more in his element in the other areas of the systematic field. Canadian agriculture, forestry, mining, manufacturing, trade, and communications are covered in a way that cannot fail to command respect. The

author's robust style holds the reader's attention at all times, and the occasional flashes of wit enliven many a weighty page of statistics. The illustrations, mostly from his own hand, are clear and pertinent if not always precise. Further, the text is amply documented and enriched with many first-hand descriptions. Few men have travelled farther or more inquisitively, and none have been more ready to do honour to those whose work has contributed to their own.

But Griffith Taylor is nothing if not exhilarating, and in his final chapter he returns to his favourite thesis—the forecasting of a country's population capacity from environmental considerations. With the help of dynagraphs which provide an index of a nation's economic potential, homoclimes, and isoiketes (population isopleths, actual and projected), he comes to the conclusion that Canada should eventually be able to support a hundred millions on central European standards or approximately fifty millions on existing North American standards. It is difficult not to be intrigued by the evidence adduced in support of this forecast, but the author fails to take into account at least two very material considerations. First, while coal, steel, oil, and hydro-electric power have undoubtedly been important factors in the population equation, there is no guarantee that they will continue to be. The advent of atomic energy and the growing dominance of plastics in industry, the raw materials for both of which are by no means restricted, and about which Dr. Taylor is strangely silent, may very well invalidate some of his conclusions. And even though "King Coal" (to use his own term) should not be dethroned in the near future, Alberta's chances of becoming another Donetz or Ruhr would still seem to be rather slight. The absence on the Prairies of navigable waterways, and the impossibility of hauling freight cheaply to sizable markets, will long operate against the establishment of big-scale local industry. It should also be borne in mind that the trend of modern industry, thanks largely to the increasing "mobility" of power, is away from rather than towards the pithead. Inferences drawn from mining localities where the pattern of industry became fixed before the days of pipelines, overhead transmission of electricity, and gassification processes should be handled with great caution. Secondly, we wonder whether it is really satisfactory to base population arguments on the "analogue" method of reasoning. Thus a proof of identity of prairie and Siberian climates (a moot point anyway), even when reinforced by their environmental similarities, would hardly seem to warrant the view that Canada can support a population of x millions at a level y, or $x/2$ millions at a level $2y$. So far as we can see, history provides scant authority for the view that mathematical artifices such as homoclimes and isopleths regulate densities of population, while the present gives little promise that the living standards of the future will be differentiated exclusively on environmental grounds. Admittedly, Dr. Taylor is prepared to halve his figures if we insist on living twice as well as the Slavs and the Russians, but in so doing does he not forget the very salient fact that while much of our northern land is doubtless capable of maintaining a given number of people on a pickled-pork–potato–homespun basis, it is incapable of supporting even a tithe of those people on the approved Canadian standard, with its emphasis on mechanization of the farm and the home, access to urban amenities and varied, high quality diet. A man's standard of living is not doubled merely by giving him twice as much land, especially when the only thing the land can grow is a surplus of root crops for which he has no market. We do not deny that there are millions of farming folk in Europe who would cordially embrace the prospect of subsistence farming in a free country, but we strongly suspect that their enthusiasm for the frontier would wane quickly after contact with it. Evidence of disillusionment in the pioneer zones is already accumulating. Unless or until we can whittle down the

differential in living standards between the "populous" and the "pioneer" regions we should be very chary of accepting any forecasts of the population-*holding* capacity of Canada's Northlands.

If I have seemed unduly critical of certain portions of this notable work, it is because I do not regard them as being in character with the man whom many of us have come to regard as the doyen of British geographers—and the most omniscient of them. But it seems that even Homer sometimes nods.

G. H. T. KIMBLE

FLINDERS' VOYAGE IN THE *FRANCIS*, 1798

MATTHEW FLINDERS' NARRATIVE OF HIS VOYAGE IN THE Schooner Francis: 1798. Edited by Geoffrey Rawson. *London: Golden Cockerel Press*, 1946. $12\frac{1}{2} \times 7\frac{1}{2}$ *inches; 102 pages; illustrations. 4 gns*

THOSE WHO read works of travel for amusement will find this book as entertaining as its editor's earlier work, 'The strange case of Mary Bryant' (London, 1938). Except for Flinders' hitherto unpublished first version of his narrative of a voyage between Port Jackson and the Furneaux Group early in 1798, which here occupies only 16 of the 102 printed pages, the volume is a pastiche of reprinted pieces and editorial comment to which the semblance of unity is given by adroit literary devices of transition and juxtaposition. It is all very readable. But the standard of self-criticism of an editor bold enough to print his own prose beside that of Matthew Flinders and George Bass should be high indeed.

The section called "Bass's journal of the whaleboat voyage" contains somewhat more than half of Bass's journal of the voyage, but the reader is not told so. The section called "Flinders' account of the wreck of the *Porpoise* and *Cato*" is from the *Historical Records of Australia* (I), vol. 4, pp. 401–6, but no acknowledgment is made to that particular series. The editor admits that he has departed from the exact style of Flinders' MS "to conform with Golden Cockerel practice" in typographical detail, and that he has "improved the punctuation in a very few places where this was desirable." The checking of passages quoted in other parts of the book does not inspire confidence in the value of such editorial tampering with the text. In a passage about Bass but quoted from Flinders on p. 20, "he had been enabled to prolong his voyage" has been changed to "he had been able to prolong his voyage"; and on p. 21, Flinders' "a country superior to any other known in the southern parts of New South Wales" has been changed to "a country superior to any other in the southern parts of New South Wales." On p. 29 Bass is said to have described land as "being of nearly the same height as Ram Head," but Bass said "being of nearly the same height as about the Ram Head." The transposition of a comma in the first, and the suppression of "that" from the second line of Bass's General Remarks on p. 42 makes a subtle difference in his alleged statement which is no improvement. Why the name of the ship *Sydney Cove* should be spelt in one way throughout the text but in a different way on the title page is not explained. In the opening sentence of the book (p. 7) we are told that the chief feature of the volume is the printing in full of Flinders' narrative of his voyage in the *Francis* in 1788, but in 1798 is meant. On p. 11 we are told that Flinders was an officer's servant in 1889! On p. 15 we are told that Bass was born in 1771, but on p. 99 we read: "1763: Birth of George Bass." The courses of vessels shown on the map on p. 101 were plotted

"from the positions recorded in the text." The outward track of the *Francis* on her voyage of 1 February to 9 March 1798 however is shown with precision in the atlas accompanying Flinders' own book, 'A voyage to Terra Australis' (London, 1814), from which it was copied for the *Historical Records of New South Wales* (vol. 3, pl. facing p. 769) and by Scott ('The life of Captain Matthew Flinders, R.N.,' Sydney, 1914).

Mr. Rawson has tried to explain the importance to Australia of the work done by Bass and Flinders in 1797 and 1798; but he has failed to appreciate the discovery by Bass of Twofold Bay which became an important whaling station; and he has not shown clearly what the geographical results of Flinders' voyage in the *Francis* were. The Kent Group was discovered and the detailed hydrographical survey of the Furneaux Group was begun. It may not now be possible to distinguish the work Flinders then did on the *Francis* from what he did on the *Norfolk* later in the same year, even with the aid of the early charts for which he wrote his 'Observations on the coasts of Van Diemen's Land, etc.' (London, 1801); but the sum of his work in the group is expressed by the inset on sheet V of his charts of the south coast of Australia in his atlas to 'A voyage to Terra Australis,' and the information he brought back to Sydney in March 1798 was of great use to the Bass Strait sealers.

In spite of its unreliability in detail, Mr. Rawson's work is not without historical value. Thanks to the Rev. Canon A. M. Cook, Vicar of Boston, Lincs., he has added a few notes and one correction to our scanty biographical knowledge of Bass; and he has drawn attention to an error in Scott's work which had already been noticed by Bryant ('Captain Matthew Flinders, R.N.,' London, 1938). Scott thought that the voyage of February–March 1798 was the first the *Francis* had made to the Furneaux Group. Bryant thought that it was the second, and Mr. Rawson seems to agree with him. Flinders himself showed clearly that it was the third ('Voy. to Terra Australis,' I, pp. cv and cxx) and his statements are supported by Collins ('An account of the English colony in New South Wales,' 2nd ed., London, 1804).

Scott, an historian of merited reputation, was unfortunate in his treatment of Bass and Flinders, for this was not his only lapse in his work on them. In "The life of Captain Matthew Flinders, R.N.,' he made extensive use of Bass's journal of the whaleboat voyage of 1797–98 and quoted frequently from it. In his later work, 'Australian discovery' (London and Toronto, 1929) he made the strange statement that Bass's papers "unfortunately, have disappeared" and printed Flinders' account of Bass's voyage instead of Bass's own journal.

The history of the exploration of Bass Strait is indeed in need of further correction (*Times Lit. Suppt.*, 2 August 1947, p. 391). A few writers, like Scott and Dunbabin, know that the strait was discovered through Governor Hunter's sustained belief in its existence in spite of Furneaux's contrary opinion. But many, including Mr. Rawson, assume that Bass's analysis of his experience on his whaleboat voyage led to the belief. George Barrington is a witness to be treated with reserve, but he was in a position to record the gossip of his time. In his account of the rescue of the survivors of the *Sydney Cove* he wrote: "These people, provided only with a small boat, made several excursions; and it appeared that this part of the coast of New South Wales was formed of a group of islands, reaching as far as they had seen to the Westward. From these, and observations he had made when on that part himself, the Governor conceived it highly probable that there were many passages or straits through to the ocean Westward, making Van Diemen's land, the southernmost part of New South Wales, an island" ("The history of New South Wales, etc.,' London, ed. of 1810, vol. 2, p. 214). All doubt of Hunter's claim to an important share in the discovery should

be set at rest by his despatch to Nepean dated 3 September 1798, months after Bass's voyage in the whaleboat and Flinders' voyage in the *Francis*. Mentioning "an opinion which I ventur'd to give from some observations of my own—that there was a probability of an open strait, thro' between the latitudes of 39° 00′ S. and 42° 00′ S.," Hunter continued: "To shew how far the conjecture I made may have been just, I directed Mr. Flinders to take into one chart the observations of Mr. Bass and his own; and I send a copy to be laid before their Lordships. From this little sketch it will appear that the high land in latitude 39° 00′ S., which Mr. Bass went round, is the southern extremity of this country, and that the land call'd Van Dieman's is a group of islands laying to the southward of that extremity, and probably leaving a safe and navigable passage between; to ascertain this is of some importance. I am endeavouring to fit out a deck'd boat of about fifteen tons burthen for that purpose, in which I propose to send the two officers above mentioned" (*Hist. Rec. Australia* (I), vol. 2 (1914), pp. 220–1).

In his first version of his report on the work of the decked vessel (the *Norfolk*), Flinders stated that Hunter had named the strait after Bass "as a just tribute to the extreme dangers and fatigues he had undergone in first entering it in the whaleboat." (*Hist. Rec., N. S. Wales*, vol. 3 (1895), p. 816.) Years later Flinders changed his full-stop into a comma and added "and to the correct judgment he had formed from various indications, of the existence of a wide opening between Van Diemen's Land and New South Wales" ('Voy. to Terra Australis, I, 1814, p. cxciii). King, Hunter's successor, in instructions to Grant dated 5 March 1801, said that the strait had been "so named after the surgeon of His Majesty's ship Reliance, who first established the certainty that such a passage existed" (*Hist. Rec. Australia* (I), vol. 3 (1915), p. 62). M. AUROUSSEAU

REVIEWS

EUROPE

LES ALPES OCCIDENTALES. Tome 2, Les Cluses préalpines et le Sillon alpin. Tome 3, Les grandes Alpes françaises du Nord. Tome 4, Les Préalpes françaises du Sud (with separate case of maps). By RAOUL BLANCHARD. *Grenoble and Paris: B. Arthaud,* 1941, 1943, 1945. 10½×7 *inches;* 670, 698, *and* 959 *pages; maps, sketch-maps, and illustrations*

Professor Raoul Blanchard's study of the Western (French) Alps was completed during the recent war: Volume 1, "Les Préalpes françaises du nord," appeared in 1938 and was reviewed in the *Geographical Journal* (93 (1939) 441). As the result of the publication of this major work, we now have detailed regional studies of the Alps in their entirety, for Professor Blanchard's researches are comparable in scope with those of Professor J. Früh, incorporated in 'Der Schweiz' (three volumes, 1930–45), and the older work of Professor N. Krebs, 'Die Ostalpen u. das heutige Österreich,' published in 1927. Professor Blanchard's life-long research on problems of alpine geography, carried out with the University of Grenoble as its focal point, follows the regional divisions of the French Alps which we have been given in earlier studies by the author. Dealing first with the Northern French Alps, Professor Blanchard proceeds to describe the Pre-alps in Volume 1, following this with an analysis of the pre-alpine *cluses* and the alpine trench (*sillon*) in Volume 2. The third volume deals with the High Alps of the North, divided into the Central Massifs and the Intra-alpine zone. The last volume, completed under conditions of unique difficulty during the latter years of the war, describes the southern Pre-alps. A separate folder with eight maps on a scale of 1:80,000 accompanies the last volume.

In Volume 2 Professor Blanchard sets out a detailed description of the *cluses* of Grenoble, Chambéry, Annecy, and the Arve, together with a study of the *Sillon alpin* between the Pre-alps and the Central Massifs. Here he finds a comparison with the valleys of the northern Tirol rather than with the Swiss or southern French Alps. The Alpine trench is not a simple monoclinal feature but the product of a series of eroded valleys, unequally affected by glaciation. The *cluses* are characterized by an alternation of *ombilics* and *verrous*, well illustrated by the lower Romanche valley. Professor Blanchard's full descriptive text suffers in the opinion of the reviewer from poor cartographic illustrations, offset however by a number of fine full-page photographs including some taken from the air. It is surprising, in such a work, to find no geological map other than detailed local sketches, and no morphological map before page 176. This does not assist in following the complexities of the text. Several unit dot maps are included but, as they are not related to physical or other features, they are rather ineffective. Again, the key to the geological sketch-maps and sections is commonly inverted (pp. 181, 184) or shows no order (Vol. 3, p. 193).

The third volume deals with the *Massifs Centraux* and the Intra-alpine zone. Here hydro-electric power and associated industries rather than tourism are significant and have served to check rural depopulation, which has been less pronounced here than in the Pre-alps. This volume is illustrated by map fragments reproduced from the National 1:80,000 series. The choice of such cartographic illustrations, using hachures to depict relief and most difficult to decipher, seems strange in view of the fact that the French Alps are fully covered by the modern 1:50,000 series, the cartography of which compares

well with the new (Siegfried) series of the Swiss topographic maps on the same scale.

The southern French Pre-alps, the subject of Volume 4, are the largest division of the French Alps and receive very full and balanced treatment. Professor Blanchard finds that climate and vegetation, together with a traditional economy and type of settlement, unify the region and much attention is paid to these features. Maps showing the northern limit of the olive, the Aleppo pine, evergreen oak, broom, and thyme serve to illustrate the difficulty of defining Mediterranean features on an ecological basis. The complexities of structure and relief, especially in relation to Pyrenean trends, are described in full. An interesting map (p. 240) showing the estimated original thickness of the folded limestones illustrates how the present course of the Drôme above Die is superimposed. In the economic section Professor Blanchard examines the three agricultural zones, Pre-alpine below 300 metres, middle mountain from 300 to 1200 metres, and high mountain above 1200 metres, and he relates the development of local industry to the "dead" season agriculturally. In conclusion, demographic features of the region are examined; the causes of emigration, both seasonal and permanent, and also of immigration from other western Mediterranean lands. In this last volume, the same generally high standard of photographic illustration is maintained but the separate map folder invites the same criticism as the maps in Volume 3. These samples of cartography of the Napoleonic era do not seem to find a fitting place in a work of such a high standard of scholarship as Professor Blanchard has given us. A. F. A. M.

DEVON AND CORNWALL: a preliminary survey. Issued by the Survey Committee of the University College of the South-West. *Exeter: A. Wheaton*, 1947. 9×7 *inches;* iv+318 *pages; maps, sketch-maps, diagrams, and illustrations.* £1 11*s* 6*d*

This interesting study of Devon and Cornwall was prepared by the Survey Committee of the University College of the South-West in order to assist in the post-war reconstruction of south-west England. Congratulations are due to the College on associating itself so closely with the needs of the region it primarily serves, and to the Survey Committee on publishing a report likely to prove of value in solving many current problems. The survey is divided into seven main sections: Population; Geology, structure and scenery; Minerals; Climate; Fisheries; Agriculture; and Industry and trade. All of these are intimately connected with current economic and social problems, and, under their appropriate headings, deal not only with the internal features of the two counties but also with their relationships to the wider area of south-west England and to the country as a whole. It is unfortunate that the very nature of the study and the time at which it was undertaken do not permit the use of a full range of up-to-date statistics; the recent trends of only the mineral industry and of the industrial structure are traced to 1943. This disadvantage is however in a large measure counter-balanced by the specialized knowledge of the authors who, with the assistance of local administrative officers, university students, and others, have been able to draw an intimate picture of the life of the region. From this the major problems arising from an actual decrease in the number of the inhabitants or in a rate of growth lower than that of the rest of the country are easily diagnosed. Ample scope is also offered for investigating the regional movements of population, which are most marked by a decrease in inland agricultural areas and by an increase along the coasts, and in their repercussions in an increasing dependence on a seasonal tourist industry. The real "feeling" of the region is above all expressed in the sub-sections dealing with the shopping and

entertainment centres and in the relationships of the towns to their hinterlands. The sections on minerals, fisheries, agriculture, and industry and trade fill in the picture of the life of the counties by discussing in more detail the principal occupations and estimating the chances of each in the future. The section on industry and trade accomplishes far more than its title suggests, for it provides a summary of the distribution of all forms of employment in the region (which may profitably be read in conjunction with that on population) as well as a general analysis of the future prospects of the region as a whole.

Obviously such a study includes much which can hardly be regarded as geographical. Yet this survey provides the best single source of geographical material for Devon and Cornwall so far published. From the geographical point of view however a number of criticisms arise. The relationships of the geology and of the climate to the life of the region, and especially to the agriculture, could have been stressed with advantage. At present these two sections stand somewhat apart from the rest of the work. The section on the climate is particularly brief and would have been strengthened by maps and diagrams, whilst a geological map would have assisted in the understanding of the section on geology and structure. The survey is on the whole well illustrated by an excellent series of maps, but it is unfortunate that, owing to the method of binding, many of the double-page maps are so far separated from their relevant text. This is especially true of the two interesting soil maps to which virtually no reference has been made. The map showing the "increase and decrease of population between 1921 and 1931 by births and deaths and by migration" scarcely does justice to the text and needs a revised key. Fuller titles would have facilitated the use of several of the figures in the Fishery section, especially Fig. 23 which has no underline and is separated from its relevant text by a double-page map. The series of pictographic charts of industrial employment is marred by an elementary mistake in Chart 2 arising from the transposition of place-names.

The Foreword lays no claim to the completeness or finality of this survey but suggests that in due course other studies will appear, unhampered by the handicaps of war-time investigation. The reviewer looks forward to the future publications of the Survey Committee and hopes that a detailed survey of the communications of the South-West will be amongst the first to appear. The need for such a survey is apparent throughout the present publication and is specifically admitted in its closing pages. C. F. W. R. G.

BRITAIN AND WORLD TRADE: a report by P.E.P. *London: Political and Economic Planning*, 1947. $9\frac{1}{2} \times 7\frac{1}{2}$ *inches;* 199 *pages.* 18*s*

This study of the trade of Great Britain has appeared at an opportune moment, when it has become urgent that our economic position should be as widely known and discussed as possible. The post-war economic crisis stands in marked contrast with the crisis of 1931–32, in that the facts of the present situation are relatively easy to come by and to understand. But the comparative simplicity of the problem is not matched by any easy solution.

In the opening chapters of 'Britain and world trade' the trends in the development of trade during the 'thirties are summarized. The change from a multilateral pattern to a bilateral pattern is sketched broadly. This section attempts, perhaps rather unwisely, to simplify a difficult problem. It is a little tendentious to describe the choice before the world as "Hull or Hitler." The problem as it affects Great Britain is treated more fully, and the rest of the book is an admirable study along lines that have now become only too familiar: Britain's disinvestment during the war years, the adverse balance of trade, the need for more

exports, and the greater need for dollars than for other currencies. Restriction of imports as a means of reducing expenditure of scarce currencies, and the extension of overseas markets as a means of earning more, are both considered. The book is well documented and the statistical appendices are good. It may be recommended to all who cannot easily assimilate official pronouncements and White Papers, and to those geographers who need to view the pattern of production and trade against the background of these disjointed times.

N. J. G. P.

MEDIAEVAL CASTLES IN NORTH WALES. By E. NEAVERSON. *Liverpool: University Press; London: Hodder and Stoughton*, 1947. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* vi+54 *pages; diagrams and illustrations.* 6*s*

The study undertaken by Dr. Neaverson shows a most unusual approach to the interesting subject of medieval castles. The general reader who happens to know no geology will probably find the work, of necessity, too technical but the serious student of medieval castles should be most grateful to Dr. Neaverson for bringing together the basic facts of geology which control the topography of the site, the problems of water supply, and the type of available raw material.

The author gives an authoritative description of the rock used in the construction which will be of value in ensuring that future descriptions are made in the correct technical terms. Chapter 2 on the general geological features of North Wales is an excellent, though necessarily brief, account of the geology of the area. References are made to the building stones found at the various geological horizons and in this way Dr. Neaverson is able to bring out the connection between the geology and the material used in the building of the castles.

W. B. R. K.

U.S.S.R.: a concise handbook. Edited by ERNEST J. SIMMONS. *New York: Cornell University Press*, 1947. 9×6 *inches;* viii+494 *pages; dust-cover map.* 25*s*

Collected lectures on related subjects, however effective and eminent the lecturers, when published do not always result in the most successful of books. This volume, a collection of articles based on lectures given at Cornell University in 1943 and 1944 on a "Study of contemporary Russian civilization," succeeds generally in presenting a complete, balanced picture of the main aspects of a very broad subject. Its 500 pages consist of lecture topics grouped under four headings: Geography, Political Science, The Social Sciences, The Humanities and Science. Each subject is handled by an expert, mostly American, but Sir Bernard Pares deals soundly with "The First World War" and "Religion under the Czar and Soviets."

The book is encyclopaedic in scope and form; emphasis falls on fact rather than on comment or opinion. The method of compilation leads to some repetition of information—not a serious fault when the matter is so concentrated. Some chapters are particularly satisfying. Those on Industry and Communications deal adequately with their subjects, and effective summaries are given on "The educational system," "The Arts," and "Social institutions." The chapter on "Agricultural development," while generally good, omits such important aspects as the extension of orchard cultivation, irrigation, and the practice of dry farming.

Part 1, Geography, consists of two chapters: "National and racial minorities" and "Physical features." The latter falls below the general high standard of the book. An attempt to give what is virtually a geography of the U.S.S.R. in fourteen pages must result in sketchiness and superficiality. The student would be rather misled by the statement that the River Amur rises "not far" from

Lake Baikal, and would derive little profit from the sentence "The soil of the forest zone is known as podzol" unsupported by any explanation. In another chapter "podzol" is defined as "non-black soil."

Bibliographies, mainly of Russian and American sources, appear at the end of each chapter. Apart from a large general map forming the dust cover, there are no maps. This detracts considerably from the value of those sections dealing with distributions and with military campaigns. This rather ambitious volume may be recommended as a useful summary of factual information, covering all the main aspects of the land, peoples, and institutions of the Soviet Union to the date of writing. D. W. S.

CLASSICAL LANDSCAPE WITH FIGURES. By OSBERT LANCASTER. *London: John Murray*, 1947. 9½×6½ *inches; 224 pages; illustrations.* 15*s*

Mr. Osbert Lancaster has produced a jaunty and yet brilliant book. His work at the British Embassy gave him ample opportunity to survey the Greek political scene, and at the same time to indulge his taste for art and archaeology and his skill as an artist. But a large part of the book is devoted to politics, and here at least the author's humorous sallies seem sadly misplaced. He has many prejudices. He dislikes scoutmasters; he jibes at dons, schoolmasters, and professional archaeologists, to whom whole generations of young visitors to Greece owe much and who, so far as one's memory serves, were in no sense blind to the beauty of the Greek landscape. But that Mr. Lancaster has a genuine feeling for the Greece of dons and archaeologists is apparent from his description, at the end of Chapter 3, of sunset over Athens, and from his observations on Mycenae and Tiryns.

Mr. Lancaster has much to say about medieval Greece. His description of Byzantine architecture is perhaps the outstanding feature of the book, and he has visited most of the castles and sites connected with the Frankish occupation, one of the most fascinating periods of Greek history, when minstrelsy, courts of love, and jousting reached a pitch of luxury and refinement unmatched in other lands. The illustrations are extremely clever, but the author's genius for caricature is apt to run away with him. There is scarcely a picture without some comic figure to distract attention from the buildings, landscape, and blue sky flecked with clouds with which Mr. Lancaster adorns his book. One could wish that he had been a little more austere. Irony is a dangerous weapon, to be used sparingly and with a minimum of words. The sentences are often too long and involved; one sentence runs to 100 words with only three commas. The book, in short, is good but with a little care and pruning it might have been better.

M. L.

ASIA

GEOLOGY AND WATER RESOURCES OF PALESTINE. By G. S. BLAKE and M. J. GOLDSCHMIDT. *Jerusalem: Dept. of Land Settlement and Water Commissioner*, 1947. 9½×7 *inches;* iv+414+14+lii *pages; illustrations. Folding maps and diagrams separate.* £P2

It is sad that of all the innumerable reports that have been published during the period of the British Mandate, only a tiny fraction have been concerned with the knowledge and study of Palestine's natural resources. This most valuable publication itself owes its appearance more than anything else to the personal energies of its authors, as is hinted in the Foreword. G. S. Blake was killed in tragic circumstances in 1940 after twenty years' work in Palestine while on a geological expedition south of the Dead Sea. By his death all the communities in Palestine lost a devoted public servant and friend. M. J. Goldschmidt had long

worked with Blake, being chiefly concerned with hydrology as a complement to Blake's geology. It is to Goldschmidt who "contributed in excess of that which is expected of an efficient Irrigation Officer satisfactorily performing his technical duties," and to his diligent editing of Blake's notes and drafts that this publication is due.

It is not a book for beginners, still less for those who wish to get a quick and easy briefing on its subject. To read it requires a rigid discipline. None of it may be skimmed; each page and paragraph, in some places even every line, demands meticulous reference to the maps and cross-sections which are numerous.

The country is treated in three divisions: Northern, Central, and Southern Palestine. In each division the detailed study traverses geology, topography, structure and stratigraphy, and finally hydrology. Despite the symmetry of its form the span is not as wide as the title and the headings of these sections suggest. At one end of the scale—geology—a knowledge of the general geological background of the region is taken wholly for granted. At the other end—hydrology—the survey stops short of the rivers and streams and the characteristics of their flow. In fact, the focus is on the junction between the geological and the hydrological. Each section plunges straight into geological detail and ends with hydrological detail; there is little summing up in broad conclusions.

To those who look for ready-made ideas these may seem like defects. But to serious students of this and succeeding generations who want original facts they are merits. The book is a detailed record of the accumulated facts and experience of half a working life and, as such, does not belong so much to any particular point in time or to any particular state of opinion, but to the archives of knowledge.

There are few subjects more difficult to present than a combination of geology and hydrology. It requires a series of three-dimensional descriptive portrayals —topography, geology and stratigraphy, and the subsurface water contours. All of them are interrelated and have to be thought of together, and the author's difficult task is to link up his text with the several kinds of maps and cross-sections required. It is a severe test, in this case obviously made still harder by the fact that Goldschmidt has had to work from Blake's unfinished drafts and perhaps to interpret half-formulated notes; and in circumstances during the war and after which must have placed every possible handicap in his way. Nevertheless the criticism has to be made that a great deal appears in the text which cannot be identified on the maps and sections, and that the paucity of outline sketch-plans to illustrate specific descriptive appreciations in the text imposes a very formidable burden on the reader. These defects are specially to be regretted in what must be regarded as a standard work.

One of the most interesting sections is that dealing with Southern Palestine, the much-discussed Negeb, and the Jordan Valley. This section is in effect Blake's detailed report of the Hydrological Survey of 1937–38, carried out on the recommendation of the Peel Commission. It was on this survey, whose details now appear, that the Partition Commission based their evidence on the possibilities of developing the Negeb through irrigation from wells. Their conclusions were negative though they have often been disputed since. Those who have the necessary technical skill may now study the original data and see for themselves whether the Partition Commission or their critics were better in line with the facts.

There are many important aspects of the hydrology of this region which still need to be filled out. This study is mostly "static" in the sense that it hardly touches the time dimension—that is, seasonal and annual variations of water

level and flow, especially of the springs and rivers—and the correlation of all these with rainfall. Perhaps the present study might better have been called the 'Geology and underground water resources of Palestine,' leaving a companion volume, to be entitled 'The surface water resources of Palestine,' to follow: it is very much needed. M. G. I.

SOUTHERN PALESTINE: geological map on a scale of 1/250,000 with explanatory notes by S. H. Shaw. *Jerusalem: Geological Section, Public Works Department, Government of Palestine*, 1947. *Text* $9\frac{1}{2} \times 6\frac{1}{2}$ *inches; 42 pages; folding map in end pocket* $25 \times 20\frac{1}{2}$ *inches.* 100 *mils*

In Palestine, geological studies in recent years have been greatly hampered by political events and social unrest, but despite these difficulties much quiet work has been performed by geologists in the service of the Government and by representatives of companies interested in the mineral and water resources of the country. The murder of G. S. Blake by bandits in 1940 when engaged on a geological survey in the Dead Sea area was a great loss, and his book 'Geology and water resources of Palestine,' published in 1928, was a most valuable contribution. Both he and Dr. Picard of the Hebrew University are given credit by Shaw for material help in compiling the presentation of data. In his official capacity the author has assembled information incorporating the results of his own observations with those of a number of competent geologists who have investigated an area almost uninhabited and visited by few. Without doubt aerial photographs taken by the R.A.F. have proved of great service in elucidating structural and stratigraphical features, and the services of Major A. Gluck in interpreting the aerial photos and transmitting results to maps are given well-deserved recognition. The author also pays a tribute to the valuable work of the geologists engaged by the Oil Companies, and expresses gratitude to the Oil Companies for permission to publish data placed at his disposal.

Having made a flight over some of the territory neighbouring that described, the reviewer can bear witness to the valuable aid afforded by air reconnaissances and photography in such an arid country where outcropping strata stand out in bold relief on a rugged surface. Viewed stereoscopically the air photos gave a wonderful picture of structural conditions.

The map covers an area of about 16,000 square kilometres of arid country where rainfall never exceeds 150 mm. a year and may be less than 50 mm., except on the Transjordan plateau where it may reach 200 to 500 mm. at 1200 to 1500 metres altitude and enable crops to be grown. No perennial streams exist, and potable water is scarce. Hot, dry, parching winds and wide differences of temperature favour denudation of rocks, so that except where protected or sheltered by blown sand or alluvial deposits, structural features are well exposed. Differential weathering of hard and soft beds on outcropping inclined rocks having a general north-east to south-west strike tends to accentuate geological features.

The Wadi Araba, which reflects the continuation of the Rift Valley southwards, carries the drainage of much country on both its eastern and western sides, the tributary wadis often being marked by alluvial fans. The watershed of Wadi Araba is fixed at 280 feet above sea-level at Ghor el Afram, approximately 90 kilometres from the Dead Sea and 75 kilometres from the Gulf of Aqaba with gradients of 1 in 140 to the north and 1 in 270 to the south.

Only in Transjordania and near the Gulf of Aqaba is there any very considerable exposure of the igneous basal rocks, nor is there anywhere any extensive outcrop of Palaeozoic formations. The sedimentary strata exposed mainly comprise beds of Cretaceous and Eocene age with minor developments of

Triassic and Jurassic strata; many horizons are readily distinguishable by lithological characteristics where fossil evidence is scarce or unobtainable. Intrusions and sills of volcanic rocks of the basaltic type are found on some of the structures.

Structurally the formations have a general north-east to south-west trend and take the form of monoclines or asymmetric anticlines having their steeper flanks dipping south-east. Two large, pronounced anticlinal structures in the northern part of the map constitute the most striking physiographical features, as the edges are marked by cliffs encircling an eroded region about the crest. Just beyond the frontier in Sinai is another striking dome which has been mapped by Dr. Little of the Egyptian Geological Survey. An intricate system of strike, dip, and oblique faults breaks the continuity of beds and introduces complications when endeavouring to elucidate structure.

No evidence of minerals in economic amounts was disclosed by the investigations, but in any case only very rich occurrences would justify development in such a remote, uninhabited, and inhospitable country. Traces of copper and manganese were found and the presence of slag showed that the former was at one time worked; but it was always realized that petroleum prospects were the most probable. Although no indications of oil were found, their absence *per se* could not be regarded as conclusive evidence of its non-existence. However, the two main anticlinal structures that would command the attention of oil geologists expose beds in the crestal zone so deep in the geological succession that prospects would appear remote. In the case of the Wadi Raman anticline, Triassic rocks are exposed on the steep, faulted south-east side, but other complications arise from the presence of numerous basaltic intrusions round the edge of the fold.

Intensive geological and geophysical studies and persistent prospecting with the drill in Egypt and Sinai have been rewarded by the discovery of several oilfields under conditions not greatly differing from those met with in Palestine, so it would be unwise to draw too sweeping deductions.

This little book of forty-two pages and map reflects credit not only on the author but upon those who produced them. The many measured geological sections incorporated in the text will aid the work of others who may wish to extend investigations into this deserted region. A. B. T.

HISTORICAL RECORDS OF THE SURVEY OF INDIA. Volume 1. 18th century. By COLONEL R. H. PHILLIMORE. *Dehra Dun: Geodetic Branch, Survey of India*, 1945. $11\frac{1}{2} \times 8\frac{1}{2}$ *inches;* xx+418 *pages; maps and illustrations. £2 7s 3d*

To write the early history of the Survey of India from its original records—maps, instructions, correspondence, and military reports—is no light task. Some of the documents have lain buried among the archives in Dehra Dun, Calcutta, or elsewhere for over one hundred years. Those at Dehra Dun alone include more than 700 volumes of correspondence before the year 1800, mostly in excellent preservation; elsewhere, particularly in Calcutta, some have suffered severely from the climate, insects, and fire. Towards the end of his service in India Colonel Phillimore recognized the wealth of original material that had survived and on his retirement in 1934 he undertook the monumental task of rescuing it before it perished.

The volume under review, which takes the history to 1800, is the first of a series. The second volume (1800–15) is already in the press; the third (1815–30) is under preparation; a fourth, which will carry the history through Everest's period of service from 1830–40, will not be ready for the press for some years

though preliminary work on it has been begun. It is to be hoped that the Government of India will realize the importance of publishing these records and will continue to give Colonel Phillimore every encouragement and help to continue his great work.

Most geographers are familiar with 'A memoir on the Indian surveys,' written in 1871 by Sir Clements Markham when Geographer to the India Office. It is a fascinating story, but it devotes less than twenty pages to the period before 1800, and unless access is available to original sources, leaves the student rather at a loss. Moreover some have been led to believe that the measurement of Lambton's Madras base in 1803 was the real origin of the Survey of India, whereas it was rather the beginning of a new era, that of the Great Trigonometrical Survey, under which the whole of the Indian surveys was placed on a trigonometrical framework instead of an astronomical one.

Phillimore's researches are far more valuable to the student. After an introductory chapter, which rightly in a book of this nature assumes that the reader knows the general outline of Indian history, his general arrangement has been to describe successively the surveys undertaken in each of the three presidencies as they were expanded, with a special chapter on surveys "Beyond the Barriers"—in Tibet, Nepal, Burma. This last is particularly important as revealing the origins of some of the faulty conclusions of eighteenth-century geographers regarding the sources of the Ganges and other Himalayan rivers. Chapter 9 is devoted to Revenue Surveys; Chapters 10 to 13 to the astronomical controls in the different presidencies and to the instruments used; Chapters 14 to 17 to the maps, typical and historical, their methods of construction and reproduction; and the last six chapters to personnel and administration. At the end there are nearly a hundred pages of biographical notes of over 200 noteworthy men, foreign as well as British, who contributed to the map of India from earliest times to 1800, compiled from original and contemporary sources and fully documented.

It is impossible in a short review to pick out more than a few salient points. Military route surveys figure largely among the topographical work, and extracts from the surveyors' diaries light up the difficulties met and overcome. Of great interest is Clive's immediate realization after the Battle of Plassey of the necessity of a map of the Company's lands in Bengal, the support he received from the Directors in England, and the enthusiasm with which the surveyors undertook their work in the unhealthy lowlands of Bengal. James Rennell is of course the outstanding figure throughout the period, both in India and in England—he died in 1830, aged eighty-seven—but Colonel Phillimore has not allowed his enthusiasm for the master to dim the lustre of lesser stars.

Colonel Phillimore calls his volume a collection and compilation. Unless all historians are compilers this is far too modest; it is an original work of considerable importance. He generously acknowledges the help he has received from all quarters; but it was he who travelled backwards and forwards between the three presidencies and between the libraries of India and England and fitted together the jigsaw story of all the relevant pieces, and who has seen his work through the printing stages of a single private departmental press in India. Most of the Addenda and Corrigenda are minor misprints, such as are bound to occur in a book printed under great difficulty without trained proof-readers during wartime, when the author has had to snatch odd moments to correct the proofs. It is no disparagement of a book of this nature to add that other minor errors will be picked up by the expert and certainly by the author himself, some of which will come to light as the result of Volume 2. The very completeness of the index and documentation will make the discovery of any such errors easier. K. M.

MALAYA AND THE MALAYANS. By E. H. G. DOBBY. (Golden Hind Geographies, first series, book 3 (A).) *London: University of London Press*, 1947. $7\frac{1}{2} \times 5\frac{1}{2}$ *inches; 176 pages; maps and illustrations*

This book is a text intended for pupils of nine to eleven years of age in Malayan primary schools. Its author is Dr. Dobby, Head of the Geography Department of Raffles College, Singapore. Books of this type are not usually reviewed in the *Journal*, but an exception is made in this case because of its pioneer character. In the main, colonial schools have to rely upon geography texts written for English pupils. This book takes the place occupied by a book on the British Isles in a series of four designed to meet the needs of children of primary-school age in this country. The other three, written by two teacher Fellows of the Society, are equally suitable for Malayan children as they give simple accounts of life and work in the world as a whole. Thus the Malayan schools have now available a first geography of their own homeland written by an expert who knows the country well.

It is understood that Dr. Dobby is writing a more advanced book for secondary schools. This will deal with Malaya in a setting of South-east Asia. L. B.

AFRICA

A DEVELOPMENT PLAN FOR UGANDA. By E. B. WORTHINGTON. *Entebbe: Uganda Government Press*, 1947. 10 × 8 *inches; xii+112 pages; sketch-maps and diagrams. Shs* 2.50

Thanks largely to its peasant agricultural production, Uganda is probably the most prosperous of the East African Dependencies. But here as elsewhere an increase of human fertility—a result of public security and improved social conditions—is marked by a decrease of soil fertility. Prudently it has been decided both to examine the foundations of this prosperity and to consider the nature of the more elaborate structure which they are likely to be called upon to support. Dr. Worthington's 'Development plan' represents "a designer's preliminary sketches."

Many of its proposals follow familiar lines, and departmental heads will be happy to see more than one pigeon-holed project accorded a reasoned place in the pattern of things to come. The proposed order of priorities is however important. For some time past there has been an emphasis on social services, such as health and education; without neglecting these, the plan advocates that first attention should now be given to the encouragement of productive effort. Accordingly stress is laid on the need for improved rural water-supplies, for an offensive campaign against the advancing tsetse-fly, for the conversion of swamps to cultivable land, and for a modernized fishing industry. Expanded agricultural, animal husbandry, and forest services would concert their activities in the interests of soil conservation. The most imaginative proposal is for a series of some eight "pilot development schemes" in which to try out progressive ideas both of efficient land-use by the aid of mechanization and of social services, as well as schemes of intensive production. Typically a pilot-scheme would be sited in an under- or unpopulated catchment area of 500 square miles ultimately supporting perhaps 6000 African families. An expenditure of one million pounds within ten years might be involved in each scheme.

It is probably true that political rather than economic advance has until recent years tended to preoccupy the minds of those responsible for British colonial territories. Dr. Worthington's terms of reference seem to have permitted him largely to ignore the political and psychological aspects of his

proposals. Those who will have the task of putting them into practice are not likely to be so fortunate. There is perhaps an equally exigent case for a complementary Development Plan for human relations. The often narrow interests of diverse native authorities have yet to be articulated with the needs of modern central government; the African has still to learn the profound truth that in the material world "you have to pay for everything you get." Over all are unresolved problems of inter-tribal and inter-racial relations. If Africa is to escape the human miseries which are marking the period of growth in the Far East, courageous and unconventional experiments in partnership and integration will be needed, particularly as between the considerably enlarged European element, which is essential for the successful prosecution of Dr. Worthington's proposals, and the numerically small but clamorous body of emergent Africans.

H. B. T.

THE NUBA: an anthropological study of the hill tribes of Kordofan. By S. F. NADEL. *London: Geoffrey Cumberlege, Oxford University Press,* 1947. 9×6 *inches;* xvi+527 *pages; diagrams and illustrations.* 42*s*

The many communities that are collectively called the Nuba have long been noted for their linguistic and cultural diversity. They were first surveyed by Professor C. G. and Mrs. B. Z. Seligman in their 'The pagan tribes of the Nilotic Sudan.' Their languages even fall into three distinct families, and adjacent tribes may be mutually unintelligible to each other. Dr. Nadel's task in attempting in two years to collect material for a handbook on the Nuba was obviously very difficult. He found there was a common substratum of Nuba culture, in economic life, lack of political development, and certain types of clan taboos. He therefore studied three adjacent tribes over a yearly cycle and seven others for an average of two months each. Unfortunately he does not say whether or where he worked in the vernacular; is it possible to conduct "a long and delicate cross-examination" through an interpreter?

He describes the basic economic life in two initial chapters. Thereafter he classifies the ten tribes into four groups on permutations of the following attributes: patrilineal or matrilineal clans; simple or symbiotic clan structure; presence or absence of a shamanistic cult. He writes one or two chapters on each group, describing the main features of their social organization and culture in contrast with each other. Finally he summarizes "Trends and prospects" and advises Government.

The book is not easy to read or to assess without some re-reading. Nadel has unfortunately attempted both to write for Government officials and to present new theory to his colleagues. This never produces a well-wrought book. He uses native terms excessively and this is a heavy burden on the reader. He also uses terms out of their accepted connotations; for example, what he calls Nuba witchcraft—the use of magic against an unknown or suspected thief or adulterer—is well known as punitive magic.

The data of the book are impressive and Nadel is to be congratulated on what he achieved in a difficult field-situation. There are also many stimulating ideas in it. The weakest part is that which is basic to the analysis; the description of the clans and their segments, and the relations of these social units to territorial groupings, is not clear. Judging by the internal evidence in the light of our general knowledge of African social organization, this part of the work requires more elaboration, since it is likely that the relationships are more complicated than they appear in the present account. The most interesting parts are on ritual, and there is useful information on the development of political structure in relation to law.

The book also aims to be "applied anthropology." I feel that Nadel's advice to Government is cast in too vague terms to be impressive.

In short, the book gives us an invaluable account of a little known and important group. It will be useful to anthropologists and geographers as well as administrators. Nadel's achievement is considerable. M. G.

CENTRAL AND SOUTH AMERICA

CUBAN COUNTERPOINT: tobacco and sugar. By FERNANDO ORTIZ. *New York: Alfred Knopf*, 1947. 8½×6 *inches;* xxi+312+xv *pages; illustrations.* 24*s*

This is a Borzoi Book, the publisher informs us, and we pass on to the introduction by the late Professor Bronislaw Malinowski of Yale University. He is mainly concerned with an addition to the English language—the word "transculturation," which Dr. Ortiz introduces in place of such words as "acculturation," "osmosis of culture," which appear to have been current in North America. The reviewer devoutly hopes that no osmosis of culture will allow this word to acculturate itself outside Yale University, and that it will not transculturate to this country.

Dr. Ortiz starts by contrasting sugar and tobacco, observing, for example, that "sugar is sweet and odourless; tobacco, bitter and aromatic." Fortunately, after a hundred pages of this sort of thing, the author leaves sugar and reaches the body of the work, which consists of a large collection of interesting scraps of information relevant to the history of tobacco and smoking generally. It is surprising that, when relating the measures taken against tobacco, from the "Counterblaste" of James I (about 1603) to the Turkish Sultan's order that smokers should be impaled, the author omits the Mogul Emperor Jehangir, who prohibited smoking in 1617; guilty persons were punished by having their lips cut. Some fifty years later taxes on tobacco were abolished by Aurangzeb. Tobacco was first brought to India about 1605 in the time of Akbar, whose smoking experiment is described by Asad Beg. 'Cuban counterpoint' is illustrated with reproductions of cigar-box labels and old prints. A. G. H. A.

MEXICAN KALEIDOSCOPE. By NORMAN PELHAM WRIGHT. *London: Wm. Heinemann*, 1947. 9×6 *inches;* vii+175 *pages; illustrations.* 15*s*

The author was for three years military attaché in Mexico City, and interested himself in many aspects of Mexican life. The result is an excellent introductory book on Mexico, which should be most valuable to newcomers to the country. He has something to say about Mexican archaeology and gives a clear table of the various cultures. The book likewise includes ethnology, and gives a statistical account of the various Indian peoples together with a brief account of the author's own visit to the Seri Indians of Tiburon Island in Sonora. The church architecture of the colonial period is briefly mentioned, and a list of principal buildings follows. Natural history receives mention, but the Jackass-Hare (*Lepus californicus*) and the remarkable tailless rabbit (*Romerolagus Nelsoni*), which is found only on the summit of Mount Popocatepetl, are strangely omitted.

The author is puzzled by the English name "buzzard" for the American carrion vulture (*Cathartes aura*). This name is an old one and the correct form appears to be Turkey-buzzard, which was used by Josselyn in 1672 ('New English rarities,' p. 12). Apparently the early settlers thought that the bird resembled both the turkey and the buzzard. The fat dogs with monstrous bodies, which the author knew only from clay effigies, were figured by Hernandez, who gives the Mexican name as *ytzcvinteporzotli*. It is strange that all

references to the voyages of H.M. Ships *Blossom* and *Sulphur* and to the 'Biologia Centrali-Americana' are omitted from the bibliography of ninety-three English writers on Mexico. The book ends with a plea for intensified British scientific collaboration with Mexico: unfortunately this is limited by our resources. The book is illustrated with excellent photographs by the author.

A. H. G. A.

O DESCOBRIMENTO DO BRASIL: estudo critico de accordo com a documentação historico-cartografica e a nautica. (Brasiliana, ser. 5, vol. 253.) By THOMAS OSCAR MARCONDES DE SOUZA. *São Paulo: Companhia Editora Nacional*, 1946. 7×5 *inches;* xviii+382 *pages; maps and illustrations*

The author, continuing his researches into the history of the exploration of the Americas, here examines the question of priority in the discovery of Brazil. Much controversy has centred around this problem, and the resulting literature is very extensive. The main points at issue are stated fairly, and contemporary documents are printed in an appendix: the author's main conclusions will command a wide acceptance. In brief, he holds that the coastline of Brazil was first discovered by Pinzon and that Cabral's landfall was accidental and not based on earlier discoveries. A number of subsidiary points are also discussed; for example, the meaning of the term "novamente descoberto" which has sometimes been taken as implying "rediscovery" rather than "recent discovery." The author points out that the term "descobrir" also bears two meanings—to seek deliberately or to find by chance—and that it is not admissible in every case to give it the first of these meanings.

G. R. C.

AUSTRALASIA

ECONOMIC RESOURCES OF TASMANIA. *Hobart: State Economic Planning Authority*, 1945. 20×15 *inches;* 27 *pages of annotated maps*

This is essentially an atlas of Tasmania's natural resources and of their utilization. The scale chosen is 16 miles to the inch, large enough to permit the adequate display of the material but small enough to make the page size quite convenient for desk use. A page of textual explanation and amplification accompanies each map, but it is the maps themselves that are the real contribution. Of these there are twenty-seven, covering the physical background of Tasmania (geology, relief and drainage, soils, precipitation) and almost every conceivable aspect of its productive activity. In general they are excellent, obviously the product of well-directed team-work both in the field and in the office. British users of the work should not need to be reminded that in the absence of large-scale base maps showing field boundaries, the fineness of pattern of the Land Utilization Survey map of Great Britain cannot be expected; remembering this, they are likely to be surprised at the degree of local detail that has actually been achieved. But the scope of this work goes far beyond agricultural utilization of the land, to include such matters as mineral production, hydro-electric power generation and distribution, sea fisheries, communication routes and services, and distribution of population, urban and rural.

In general, our picture of Tasmania has not been radically altered by this new and authoritative publication, but it has gained an areal and a quantitative precision previously lacking. The outstanding elements are still the dominance of the west for minerals, and the concentration of agriculture, secondary industries, and population in an arcuate belt lying along the north coast as far east as the Tamar and swinging south, east of the Lake country, to the Derwent and beyond; but the precise extent of this belt and the degree of development of secondary

industry at the Hobart end of it will be new to most British readers. The volume will be an indispensable reference work, easy and pleasant to use, and very well worth the labour and cost of periodic revision, say at ten-year intervals.

R. O. B.

POLAR REGIONS

LOGBOOK FOR GRACE: whaling brig *Daisy*, 1912–13. By ROBERT CUSHMAN MURPHY. *New York: Macmillan*, 1947. 9×6 *inches;* x+290 *pages; sketch-maps and drawings.* 28*s*

Dr. R. C. Murphy is probably the only zoologist now living who has been to sea cruising for whales and seal oil in one of the old New England whalers. In the spring of 1912, newly graduated from Brown University, he set forth in the hermaphrodite brig *Daisy* of New Bedford to collect specimens for the American Museum of Natural History during a cruise to the south Atlantic and the sub-antarctic island of South Georgia, leaving a young bride to await his return for eleven long months. 'Logbook for Grace' is the substance of the diary that he kept for her in the days when "radio was merely something we had begun to hear about, air mail hardly that. Going to sea as I did meant leaving the world." The scientific results of Dr. Murphy's work have appeared in no fewer than sixty-seven different articles and in his classic two-volume 'Oceanic birds of South America'; here we have a vivid record of the day-to-day doings on board the *Daisy* and of the animals and birds studied by her zoological "assistant navigator."

The voyage started from Dominica, and opened with a leisurely cruise after blackfish and sperm whales in the Caribbean and Sargasso seas, followed by a passage to the Cape Verdes to complete the whaling crew. Then back across the Atlantic again with the South-East Trades to Fernando Noronha and on to the Roaring Forties, the ship's company capturing and boiling out sperm whales, her naturalist busy collecting, preserving, recording, and laying the foundations of the 'Oceanic birds.'

In November they reached South Georgia and set about making a cargo of sea elephant oil. The *Daisy* was anchored in a cove of the Bay of Isles on the north-west coast, and her West Indians and Cape Verders slaughtered sea elephants in their rookeries on the beaches around up to half-a-day's pull away, towing rafts of blubber back to the ship to be boiled out. Dr. Murphy set up his laboratory in a tent ashore and devoted himself to his collecting and to studying the biology of the fauna, particularly of the sea elephants, of the albatrosses, penguins, and other birds. He was soon thoroughly disgusted with sealing: when conducted properly it is no picnic, but the old Yankee fashion of killing indiscriminately bulls, cows, and pups by club and lance with no thought for the future had a quarter of a century before reduced the seals to such a pitiful remnant of their former numbers that it no longer paid to hunt them. Since then they had recovered somewhat in numbers, and for some years the *Daisy* and others had made raids on the island to pick up part cargoes of oil. But in 1912 came the end, for the skipper found shore whaling-stations and a magistrate established in what had hitherto been a no-man's-land: he had to take out a licence to capture seals and although he disregarded its terms and made a largely illegal catch, he realized that the game was up. The *Daisy* was the last of the old-timers. Since then the sea elephants of South Georgia have multiplied enormously in numbers under regulated hunting; and the fur-seal too, which was thought to be extinct, has been re-established and is increasing.

The climate of South Georgia is dreadful, a succession of gales, rain, sleet, snow, and fog, but the rare clear days amply compensate for all this when the magnificent ranges of snowy peaks with every hollow filled by glaciers are

disclosed in all their glory. Dr. Murphy worked away in his wind-rocked tent preparing specimens for the museum, and made full use of the fine days for photography. His accounts of the birds and seals are delightful; perhaps his most strange find was the sepulchre of the gentoo penguins: "Near the summit of a coastal hill I came upon a lonely pond in a hollow of ice-cracked stones. Several sick and drooping penguins were standing at the edge of this pool of snow water, which was ten or twelve feet deep. Then, with a tingling of my spine, I perceived that the bottom was strewn, layer upon layer, with the bodies of gentoo penguins that had outlived the perils of the sea to accomplish the rare feat among wild animals of dying a natural death. By hundreds, possibly by thousands, they lay all over the bed of the cold tarn, flippers outstretched and breasts reflecting blurred gleams of white. Safe at last from sea leopards in the ocean, and from skuas ashore, they took their endless rest; for decades, perhaps for centuries, the slumberers would undergo no change in their frigid tomb." 'Logbook for Grace' abounds with passages as interesting and as vivid, in which Dr. Murphy not only shows his outstanding gifts as a naturalist but reveals himself as a "very pleasant and civilized person." L. H. M.

PHYSICAL AND BIOLOGICAL GEOGRAPHY

THE PULSE OF THE EARTH. By J. H. F. UMBGROVE. 2nd ed. *The Hague: Martinus Nijhoff*, 1947. 9½×7 *inches;* xxii+358 *pages; maps and diagrams.* 20 *gld*

This edition has been expanded to about double the size of the first edition, mainly by the introduction of new material or by rewriting certain chapters to include new hypotheses. Thus, under the heading of Crust and Substratum, the notion of magmatic clans has been adopted in which the extreme views of certain continental petiologists appear to be fully accepted. This is a pity as it destroys the balance between conflicting opinions which is, in general, maintained throughout the book.

Two new chapters deal with the Continental margins and Island arcs. In the former are embodied the latest researches on these features such as the seismic investigations on the American and British margins of the Atlantic Ocean. These reveal that the so-called Continental Shelf is composed to a great depth below the surface of partially consolidated sediments of various ages which overlie a gently warped-down surface of well consolidated if not crystalline older rocks such as appear on the adjoining land areas, for example the Piedmont and the Devon–Cornish peninsula.

The submarine canyons naturally come under review; beyond summarizing the many possible and several frankly impossible hypotheses the author does not carry the matter further than D. W. Johnson. He does not attempt to decide in favour of any one of them. It is rather surprising that more attention has not been paid to the remarkable break of slope that occurs at a point just below the edge of the shelf and is as clear an indication of submarine sliding on the continental slope as is any landslip scar on land. Submarine sliding has probably played a large part also in the development of the canyons themselves.

In considering Island arcs, their relation to various other phenomena such as volcanic and plutonic activity and earthquake zones are discussed. In particular, attention is called to the depth of focus of earthquake shocks in the Pacific area, to possible deep shear zones and their association with these arcs. For the origin of the arcs themselves, no better hypothesis has been found than that of Philip Lake who regards them as lying on the outcrops on the floor of the ocean of gigantic thrust planes which dip gently inwards towards the continental areas.

It is pointed out that the earthquake studies suggest a steeper angle of dip than that worked out geometrically by Lake, but at the same time there is no reason to suppose that these thrust "planes" must everywhere form plane surfaces. It is not at all improbable that a thrust which appears at the floor of the ocean with a dip of about 14 degrees may progressively steepen in depth. The agreements of so many phenomena associated with island arcs with the consequences of Lake's hypothesis are remarkable.

Considering its moderate size, the book covers a very wide range of topics; in many respects it may be looked upon as a much abridged and up-to-date version of Suess's 'Face of the Earth.' Many of these topics are still matters of argument and the reader will find, in general, well-balanced and impartial accounts of divergent views regarding matters in dispute. The book is illustrated by over 200 well-drawn diagrams and 8 plates partly in colour showing in particular the areas which have been affected by folding at different periods of the earth's history. Advanced students of geology and perhaps geography are recommended to read it. O. T. J.

THE GEOGRAPHY OF THE FLOWERING PLANTS. By RONALD GOOD. *London: Longmans, Green,* 1947. 10×6 *inches;* 403 *pages; maps and illustrations.* 30*s*

In his introduction Professor Good emphasizes the importance of Plant Geography and how the existence and distribution of plants have been controlling influences in mankind's development throughout history, a point of special value at the present time.

The book is divided into two parts. Part 1 gives very fully the distribution of the flowering plants of the world. These chapters contain a mass of information with references to an excellent bibliography, so that any reader can refer easily to more information on any particular subject. The history and distribution of the British flora has a chapter to itself. The history of the British flora illustrates well how flowering plants redistributed themselves after the catastrophe of the Pleistocene Glacial Age and also demonstrates many of the problems of distribution which still require research and elucidation. Part 1 ends with a chapter on the geological history and past distribution of flowering plants which gives shortly and clearly the results of the great work done on the subject by the Reids, Seward, Skottsberg, and other scholars. This chapter leads to Part 2, in which the causes of the distribution of flowering plants are fully discussed. Professor Good says one natural factor of distribution—the evolutionary factor—is so fundamental that it underlies all others. But he hardly touches on the question of the cytological aspect of this evolution, which in the reviewers opinion may be an important factor in the elucidation of the evolution and the distribution of some of the flowering plants. In Part 2 the different factors of distribution such as climate, soil, dispersal of plants, changes of climate, and geographical changes are fully described and discussed. Wegener's theory of continental drift, a controversial subject, is very clearly set out in the chapter on "Geographical changes" and appears, as described by the author, convincing. Much research on this theory has been carried out and many of the leading authorities are now in agreement with Wegener's theory or a modification of it. Another chapter deals with the theory of tolerance on which Professor Good is an authority. The book concludes with the story of the flowering plants, how they re-established themselves after the catastrophe of the Pleistocene Glacial Age and how new species best able to cope with the new circumstances were evolved and are still evolving. 'The geography of the flowering plants' is a

valuable contribution to the science of plant geography and will rank with the other important books recently written on this subject, A. S. Cain's 'Foundations of plant geography,' published in the United States, and E. V. Wulff's 'Introduction to historical plant geography,' published in Russia. These three books all look at plant geography from rather different angles but all are complementary to each other. The book is well printed with many useful maps and illustrations. F. C. S.

SOCIAL GEOGRAPHY

LAND LAW AND CUSTOM IN THE COLONIES. By C. K. MEEK. *London: Geoffrey Cumberlege, Oxford University Press,* 1946. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* xxvi+337 *pages.* 21*s*

This book began as a series of memoranda written by Dr. Meek between 1941 and 1943 for the information of a Colonial Office committee on post-war problems. Lord Hailey, chairman of this committee, realizing the value to Colonial governments of the widely scattered information brought together by Dr. Meek's prodigious labour, suggested that the memoranda be recast and enlarged. This book is the result. It is an important signpost on the road of development from subsistence agriculture to commercial crops which is an outstanding feature of Colonial Policy to-day. New types of crops and new methods of agriculture are transforming the systems of tenure; land is being commercialized; the basis of holding land is changing from one of community and custom to one of individualism and contract. In the past there have been cases where absence of accurate information regarding native systems of tenure has had unfortunate results. These would have been avoided if such a work as Dr. Meek's had been available for reference.

The book comprises twenty-four chapters. The first chapter on "Factors in land-holding" indicates the highly complex character of the legal, political, religious, climatic, and social aspects of native land-holding throughout the Empire. The second chapter deals with native systems of tenure generally, agricultural rights, pastoral rights, and the ownership of trees. Then come sixteen chapters which cover fully the complex of privileges and obligations associated with the holding of land in native communities in most of the British Colonies. The list is comprehensive, from the British West Indies in the West, through the whole gamut of African communities, to Mauritius, Ceylon, Malaya, and even Fiji in the East, not omitting Cyprus, and there are continual references to and comparisons with laws and systems of land tenure in India, Australia, and New Zealand. The last six chapters, including one on "Land and Muhammadan law," deal with the legal aspects of land titles and registration, pledging and mortgaging, and changes in land law. There is an appendix with extensive notes on collective farming in Russia, communal farming in Bechuanaland and South Africa, the Latafiyah estates in Iraq, the Gezira and Alternative Livelihood schemes in the Sudan, and the novel Baroda scheme in India. A glossary of terms used in connection with English land law provides parallels for many of the incidents of the developing tenures of Colonial territories. At the foot of nearly every page statements and authorities are carefully documented and amplifying notes appended. There is an index of persons, places, terms, and cases to facilitate rapid reference.

As a book of reference, Dr. Meek's work must find a place in the library and there will be many who will read it from cover to cover. This book could have been as dry as dust, but it is written with such human understanding that all those interested in agriculture, sociology, economics, and Colonial administration will find it fascinating reading.

The introduction to the book has been written by Lord Hailey. It covers seventeen pages and is a masterly summing up of the most pressing problems of Colonial lands. He says that a comprehensive study of systems of land tenure in the Colonies and the rights associated with them has long been needed. A study of Dr. Meek's work must make it apparent that this need has now been met. T. T.

ARCHAEOLOGY AND SOCIETY. By GRAHAME CLARK. (2nd edition.) *London: Methuen, 1947. 7×5 inches; xvi+222 pages; endpaper maps, sketch-map, diagrams, and illustrations.* 10*s* 6*d*

In six chapters Dr. Clark describes clearly and with authority the methods and aims of archaeology. The book is addressed primarily to those who have some training in scientific method and preferably some previous acquaintance with archaeology. Chapter 1 outlines the development of prehistoric archaeology in its social context. The second chapter, on "Discovery," explains how archaeologists know where to dig. When, as is often the case, surface indications are lacking, natural exposure, agriculture, disturbance of the surface of a country for building, for road and rail construction and other industrial works provide most clues. Though chance finds revealed by human activities are a most important source of archaeological information, such development often destroys more than it reveals. Between the two Great Wars a new method of research, air reconnaissance and photography, gradually became available to archaeologists, and, as Dr. Clark explains, under the right conditions air photography of differences in surface-soil and vegetation can yield important discoveries.

The next chapter, headed "Preservation," describes the influences of climate, soils, and geology upon constructions and objects, and by showing how much may be lacking from the material with which an archaeologist has to deal, introduces the account of "Excavation." Here the author describes how meticulous attention to detail can yield a remarkable amount of information. These sections are excellently illustrated by text-figures and plates, and Dr. Clark has done a useful service in publishing in so convenient a form a fine series of photographs of archaeological material and methods of excavation. In Chapter 5, "Chronology" is discussed and here the reader is introduced both to principles of stratigraphy and typological development, and to modern techniques such as pollen-analysis and dendrochronology which may be used for absolute dating. Chapter 6, "Interpretation," is perhaps the best in the book; the field of interpretative or occupational archaeology is one that the author has made especially his own. The reader will find here an excellent summary of the way in which archaeology can provide information about living conditions and material and cultural equipment of prehistoric peoples. The final chapter, with the same title as the book, is concerned with relations between archaeology and political theories. J. K. St. J.

ADDITIONS TO THE LIBRARY AND MAP ROOM

EUROPE

HISTORY OF THE HOMELAND: the story of the British background

By Henry Hamilton. (*Primers for the age of plenty*, 4.) $8\frac{1}{2} \times 5\frac{1}{2}$. 598 pp. Maps and illustrations. *London: G. Allen & Unwin*, 1947. 18*s*

Dr. Hamilton describes the growth of those conditions and institutions which influence the life of the citizen to-day. The emphasis is on social and economic developments, rather than political or constitutional.

THE GEOMORPHOLOGY OF A PART OF THE MIDDLE THAMES

By F. K Hare (*Proc. Geol. Assocn.* 58 (1947) 294–303; diagrams and folding map.)

THE GEOMORPHOLOGY OF THE NORTH CORNISH COAST.

By W. G. V. Balchin. (From *Trans. R. Geol. Soc. Cornwall*, 17 (1946) 317–42; illustrations.)

THE CLIMATE OF LANCASHIRE

By G. Manley. (*Mem. & Proc. Manchester Lit. & Philos. Soc.* 87 (1945–46) 73–95)

THE STRUCTURE OF THE COAL MEASURES IN THE PONTARDAWE-AMMANFORD AREA, S. WALES

By F. M. Trotter (*Q. J. Geol. Soc.* 103 (1947) 89–134.)

LES FRONTIERES DE LA FRANCE

By Roger Dion. $8\frac{1}{2} \times 5$. 112 pp. Maps and illustrations. *Paris: Librairie Hachette*, 1947

A study of the various types of frontier, and of their origins

LA VIE RURALE DANS LES MASSIFS VOLCANIQUES DES DORES, DU CEZALLIER, DU CANTAL ET DE L'AUBRAC

By Alfred Durand. *Aurillac: Imp. moderne*, 1946. $10 \times 6\frac{1}{2}$. xii+530 pp. Maps and illustrations.

This region on the western borders of the Massif Central has a well defined and individual character. In this detailed study the author examines the elements of the physical environment, the rural economy based upon dairy and beef cattle, and the history of the population and its distribution. Despite the general prosperity of the region, migration to the cities, Paris in particular, is very marked.

PORTUGAL, O MEDITERRANEO E O ATLANTICO; estudo geográfico

By Orlando Ribeiro. $7\frac{1}{2} \times 5$. viii+240 pp. Map. *Coimbra*, 1945

An introduction to the social geography of Portugal

SWITZERLAND: the traveller's illustrated guide

7×5. 260 pp. Maps and illustrations. *London: Faber* (*Berne: Verbandsdruckerei*), 1947. 18*s*

A compact, well produced and up-to-date guide book, which includes panoramas and a sectional map in colour

ASIA

THE UNITED STATES AND THE NEAR EAST

By E. A. Speiser. (*American Foreign Policy Library.*) $7\frac{1}{2} \times 5$. xvi+264 pp. Sketch-maps. *London: Oxford U.P.*, 1947. 9*s* 6*d*

The 'Near East' here coincides with the area of primary concern to the Arab League. After summarizing the history since 1939, the author deals with the present economic and social problems, and the position of the region in relation to modern power politics.

DAS KLIMA DES NÄHEN OSTENS

By H. Boesch. (*Vjschr. Naturf. Ges.* Zürich 92 (1947) 20–31)

A supplement to an earlier study, based on data for Qaiyarah

THE ORIGIN OF THE WATERGAPS ON THE YANGTZE AND CHIALING RIVERS

By S. Ting. (*Bul. Geol. Soc. China* 24 (1944) 245–58)

STONE AGE INDIA

By V. D. Krishnaswami. (*Ancient India*, no. 3 (1947) 11–57; illustrations)

A summary of present knowledge with suggestions for research

COUNTERING DESICCATION IN THE PUNJAB

By R. MacL. Gorrie. (*Geogr. Rev.* 38 (1948) 30–40)

THE LANDSCAPE OF NORTHERN BEQĀ, LEBANON

By F. D. N. Spaven. (*Scottish G. Mag.* 63 (1947) 109–15; sketch-map and illustrations)

AN OUTLINE OF THE GEOMORPHOLOGICAL EVOLUTION OF BRITISH MALAYA
By J. A. Richardson. (*Geol. Mag.* 84 (1947) 129–44; sketch-maps)

THE MANCHURIAN IRON AND STEEL INDUSTRY AND ITS RESOURCE BASE
By Allan Rodgers. (*Geogr. Rev.* 38 (1948) 41–54; sketch-maps)

LA MONGOLIA ESTERIORE E LA QUESTIONE MONGOLA
By A. Giannini. (*Universo* 27 (1947) 613–28)

ESSAI SUR L'AGRICULTURE INDIGENE AU BAS-CONGO
By V. Drachoussoff. (*Bul. Agric. Congo Belge* 38 (1947) 471–584, 783–880; sketch-maps and illustrations)

LA CONQUÊTE MINERALE DU BASSIN CONGOLAIS
By R. Cambier. (*Bul. S. R. Belge de G.* 70 (1946) 3–25)

THE AWAKENING OF MODERN EGYPT
By M. Rifaat Bey. $8\frac{1}{2}\times5\frac{1}{2}$. viii+242 pp. Sketch-maps. *London: Longmans, Green & Co.*, 1947. 15*s*

A history of Egypt from the Napoleonic invasion to the close of the British occupation, stressing the national aspect rather than European relations

COLONY AND PROTECTORATE OF KENYA
REPORT of the Development Committee. 2 vols. $9\frac{1}{2}\times7$. 140; 236 pp. Map. *Nairobi: Govt. Printer*, 1946

SOCIAL PROBLEMS AND RESEARCH IN BRITISH WEST AFRICA
By R. Firth. (*Africa* 17 (1947) 77–91; 170–80)

LIFE IN A YORUBA FISHING VILLAGE. *Nigeria* no. 25 (1946) 243–82; illustrations)

VIDA SOCIAL DOS MANJACOS
By Antonio Carreira. (*Centro de Estudos da Guiné Portuguesa, Lisboa*, no. 1 (1947) pp. 184; illustrations)

An account of the economic and social organization of a tribe living between the lower Rio Cacheu and the Rio Mansoa

NORTH AMERICA

HISTORICAL GEOLOGY: the geologic history of North America
By R. C. Hussey. 2nd ed. 9×6. xii+466 pp. Illustrations. *New York: McGraw-Hill*, 1947. $3.75

DOMINION OF THE NORTH: a history of Canada
By D. G. Creighton. $7\frac{1}{2}\times5$. viii+536 pp. Sketch-maps. *London:* R. Hale (*pr. Cambridge, Mass.*) 1947. 15*s*

PHOTOGRAMMETRIC MAPPING OPERATIONS IN CANADA
By J. Carroll. (*Canadian Surveyor* 9 (1947) Oct., 7–17)

LA CÔTE NORD DU SAINT-LAURENT
By B. Brouillette. (*Rev. Canadienne de G., Montreal*, 1 (1947) i, 3–20; ii–iii, 8–27)

WARTIME CHANGES IN THE PATTERNS OF UNITED STATES COAL PRODUCTION
By R. E. Murphy (*Ann. Assoc. Amer. G.* 37 (1947) 185–96; sketch-maps)

EXPLORING OUR NATIONAL PARKS AND MONUMENTS
By Devereux Butcher. (*Nat. Parks Assocn.*) $9\frac{1}{2}\times6\frac{1}{2}$. 160 pp. Maps and illustrations. *New York: Oxford University Press*, 1947. 15*s*

Contains a short description of each Park, with information required by visitors

OZARK SUPERSTITIONS
By Vance Randolph. $8\frac{1}{2}\times5\frac{1}{2}$. x+368 pp. *New York: Columbia University Press* (*London: G. Cumberlege*) 1947. 21*s*

Studies in the folklore of an isolated hill folk in Missouri-Arkansas who migrated from the southern Appalachians early last century

SOUTH AMERICA

GEOLOGIC OUTLINE OF SOUTH AMERICAN OIL FIELDS
By V. Oppenheim. 9×6. 36 pp. *New York*, 1946

EL CLIMA DE GENERAL PICO VINCULADO A LA EROSION EOLICA
By T. F. A. Weber. (*Gæa, Buenos Aires*, 8 (1947) 33–72; diagrams)

The area is in the territory of La Pampa

TRES CONTRIBUCIONES A LA CLIMATO-GEOGRAFIA DE TUCUMAN
By D. Gomez Omil, E. B. de Santamarina, and G. Rohmeder. (*Inst. de Estudios Geogr., Tucuman, Monogr.* 9 (1947) 44 pp.)

SUBURBIOS ORIENTAIS DE SÃO PAULO
By Aroldo de Azevedo. 9×6. 184 pp. Sketch-map and illustrations. *São Paulo*, 1945

A study of the eastern suburbs of São Paulo, whose population, despite an unfavourable physical environment, has grown from 31,000 in 1872 to 1,450,000 for the urban area in 1945

AUSTRALIA AND PACIFIC

CROSSING THE DEAD HEART
By C. T. Madigan. 8½×5½. xiv+172 pp. Map and illustrations. *Melbourne: Georgian House*, 1946

A general narrative of the expedition which for the first time crossed the Simpson Desert, north of Lake Eyre, in 1939. The rainfall over this area is extremely erratic, but the author does not consider that conditions are becoming progressively worse

THE MUSGRAVE RANGES
By A. F. Wilson. (*Walkabout, Melbourne*, 14 (1947) 8–15; illustrations)

Narrative of journeys in this arid area on the border between Northern Territory and South Australia

PRINCIPAL LAND UTILIZATION IN SOUTH AUSTRALIA
By C. M. Hambridge. (*Proc. R. G. S. South Australia* 47 (1946) 9–25; map)

COUNTRY TOWNS OF VICTORIA: a social survey
By A. J. and J. J. McIntyre. 8½×5½. xxiv+292 pp. Illustrations. *Melbourne: University Press*, 1944. 10*s* 6*d*

THE MANIOTOTO BASIN, CENT. OTAGO: from natural to cultural landscape
By Mary Aitken. (*N.Z. Geographer* 3 (1947) 59–74; sketch-map and illustrations)

NOTES ON NIUAFO'OU ISLAND
By G. A. Macdonald. (*Amer. J. Sc.* 246 (1948) 65–77; illustrations)

A summary of the petrography and volcanic history of this island in the S.W. Pacific. In 1946, the town of Angaha was destroyed by a lava flow

GENERAL

OUR EVOLVING CIVILISATION: an introduction to geopacifics
By Griffith Taylor. 9×6. xvi+370 pp. Sketch-maps. *Oxford: University Press*, 1946. 21*s*

The author studies the 'effect of various environments upon man, especially in regard to the gradual changes in human conditions which characterize an advancing civilization.' He condemns differentiation on racial grounds, but believes dominating nations must arise through advantages conferred by certain environments. Whether they lead or conquer the world is a matter outside the geographer's province.

WORLDMAKERS OF THE 17TH CENT. AND THEIR INFLUENCE ON THE EARTH SCIENCES
By E. G. R. Taylor. (*Geogr. Rev.* 38 (1948) 104–12)

ESSAYS ON HISTORIOGRAPHY
By J. C. Malin. 8½×5½. 180 pp. *Lawrence, Kansas: The Author*, 1946

These essays include a critical examination of Turner's frontier concept and its relation to Mackinder's world theories, and of recent developments in historical thought in the U.S.

MIDDLE EASTERN JOURNEY
By Bernard Newman. 8×5. 306 pp. Sketch-map and illustrations. *London: Gollancz*, 1947. 16*s*

The record of a lecture tour in 1946, ranging, despite the title, from Austria to Kenya, and aiming at providing a contemporary picture for the general reader

THE TRAVELLER'S EYE
By Dorothy Carrington. 8½×6. xiv+382 pp. Illustrations. *London: Pilot Press*, 1947. 18*s*

A survey of English travel literature mainly dealing with Europe, Asia, and America, with numerous quotations. The author's purpose is to show how the English have looked on the world, and how they have acted in it. The illustrations are well chosen

ATLASES AND MAPS

EUROPE

GREAT BRITAIN. ORDNANCE SURVEY. Administrative Diagrams of England and Wales. 1 : 126,720. 17 sheets. *Chessington*, 1947

GREAT BRITAIN. ORDNANCE SURVEY. New Popular Edition One-Inch Map of England and Wales. Sheets: 75, 86, 89, 91, 102, 109. *Chessington*, 1947

GREAT BRITAIN. ORDNANCE SURVEY. 1 : 25,000 or about 2½ inches to 1 mile. 35 sheets. *Chessington*, 1947

GREAT BRITAIN. NATIONAL PARKS and Conservation Areas proposed by the National Parks Committee (England and Wales) 1 : 253,440. 10 sheets. *London: Ministry of Town and Country Planning*, 1947

LAND UTILISATION SURVEY of Britain. England and Wales. 1 : 63,360. Sheets: 2, 10, 13, 20, 21, 25, 78, 136, 143, 145. *London: Land Utilisation Survey*, 1947

SCOTLAND. ORDNANCE SURVEY. Popular Edition One-Inch Map. Sheets: 27, 28, 38, 42, 43, 48, 52, 54, 55, 56. *Chessington*, 1947

NORTHERN IRELAND. ORDNANCE SURVEY. Six-Inch Map. Sheets: Antrim 2, Tyrone 24. *Belfast: Ordnance Survey of Northern Ireland*, 1940–1946

HÖJDEKORT OVER DANMARK 1 : 250,000.—Landskabskort over Danmark 1 : 250,000.—Odsherred, et Dansk Moraenelandskab og dets Tilblivelse 1 : 62,500. *Copenhagen: Geodaetisk Institut*, 1947

CARTE DE FRANCE AU 50,000e. 24 sheets.—Carte de France et des Frontières à 1 : 200,000. 14 sheets. *Paris: Institut Géographique National*, 1940–47

LANDESKARTE DER SCHWEIZ 1 : 50,000. 17 sheets. *Bern: Eidgenössische Landestopographie*, 1939–47

TOPOGRAFISK KART OVER SVALBARD 1 : 100,000. Blad C13 (Sörkapp). *Oslo: Norges Svalbard- og Ishavs-Undersøkelser*, 1948

ASIA

GEOLOGICAL MAP OF CYPRUS by R. V. Browne and J. McGinty 1940. 1 : 253,440. *Published by 42nd Geological Section, M.E.F.*, 1946

CYPRUS MOTOR MAP 1 : 506,880.—Nicosia and Environs 1 : 7920.—Limassol and Environs 1 : 7920. *Nicosia: Land Registration and Survey Department*, 1946

PALESTINE. Geological Map of Southern Palestine, 1 : 250,000. *Jerusalem: Public Works Dept.*, 1947

AFRICA

AFRIQUE 1/2M. 10 sheets.—Croquis de l'Afrique Française au 1,000,000e. 7 sheets. *Paris: Institut Géogr. Nat.*, 1946–47

CARTE D'ALGERIE au 50,000e. 7 sheets. *Paris: Institut Géogr. Nat.*, 1946–47

ANGLO-EGYPTIAN SUDAN 1 : 250,000. Sheet 55–I. *Khartoum: Sudan Survey Dept.*, 1946

GOLD COAST, Road Map 1 : 500,000. Two sheets. *Accra: Survey Dept.*, 1946

MAROC 1 : 50,000. 3 sheets.—1 : 100,000. 3 sheets. *Paris: Institut Géogr. Nat.*, 1946–47

NIGERIA 1 : 3,000,000. Population Map; Domestic Trade; Isothermal Chart; Isogonic map. *Lagos: Land and Survey Dept.*, 1940

NIGERIA. Provisional Geological Map. Compiled under the direction of the Director of Geological Surveys. 1/2M. *Lagos: Survey Dept.*, 1944

CARTE DE TUNISIE au 50,000e. 5 sheets. *Paris: Institut Geogr. Nat.*, 1947

ZANZIBAR 1 : 63,360. 2 sheets. *Teddington: Directorate of Colonial Surveys*, 1947

SOUTH AND CENTRAL AMERICA

ANTIGUA ISLAND 1 : 25,000. 2 sheets. *Teddington: Directorate of Colonial Surveys*, 1947

JAMAICA 1 : 50,000. 7 sheets. *Teddington: Directorate of Colonial Surveys*, 1947

SOUTH AMERICA. 1/10M. *Edinburgh: John Bartholomew & Son, Ltd.*, 1947. *Price* 4*s*

ESQUISSE PHOTOGRAMMETRIQUE DE LA GUYANE FRANÇAISE 1 : 50,000. Sheet: Cayenne. *Paris: Institut Géogr. Nat.*, 1947

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THE SOCIETY'S NEWS

RECENT ELECTIONS TO HONORARY MEMBERSHIP

In February this year the Rt. Hon. Winston Churchill, P.C., O.M., C.H., F.R.S., accepted the invitation of the Council to become an Honorary Member of the Society.

Mr. Churchill has, through his historical writings and strategic expositions, contributed greatly towards a fuller understanding of the importance of geographical factors in strategy and war. He has also, in the course of his most distinguished career, travelled more widely than most geographers. In particular his wartime travels—beginning in 1941 with his first crossing of the Atlantic at the height of the U-boat war to sign the "Atlantic Charter," continuing with trips to Moscow, the "Middle East" and elsewhere—have become almost legendary.

In March 1947 two Honorary Members were elected: Dr. Charles Camsell, C.M.G., Chairman of the Council of the North West Territories and Honorary President of the Canadian Geographical Society; and Inspector Henry A. Larsen, R.C.M.P., who, in command of the *St. Roch*, was first to navigate the North West Passage from west to east and also first to navigate it in both directions; both Dr. Camsell and Inspector Larsen were recipients of the Society's Gold Medals in 1946.

SPECIAL PUBLICATIONS OF THE SOCIETY

R.G.S. RESEARCH SERIES: GLACIOLOGICAL RESEARCH ON THE NORTH ATLANTIC COASTS

The first publication in the Society's new Research Series is now available at the Office of the Society, price 7*s.* 6*d.*, reduced to 6*s.* for Fellows. It is a study by the distinguished glaciologist Hans W:son Ahlmann, Professor of Geography in the University of Stockholm, of 'Glaciological research on the North Atlantic coasts' ($9\frac{1}{2} \times 7$ *inches;* 84 *pages; maps and diagrams*). Illustrated by numerous figures in the text, this work unites for the first time the scattered literature and unpublished results of the detailed investigations which Professor Ahlmann and his colleagues have been making since 1918 into the anatomy and behaviour of glaciers in Scandinavia, Spitsbergen, and other land areas around the northernmost Atlantic.

Of special interest is the evidence of a widespread decline of the glaciers, testifying to the present amelioration of the climate of the Arctic and Subarctic, a subject of which Professor Ahlmann has made a special study.

R.G.S. PAMPHLET SERIES: AIR SURVEY

The latest issue in the Society's Pamphlet Series is a short account of 'Air Survey' by C. A. Hart, Professor of Surveying and Photogrammetry in the University of London. Written specially for schools and for the use of teachers, it is equally suitable for anyone who wishes to be informed about the basic principles and latest developments in air survey with the minimum technical detail.

Earlier publications in this Series are 'The making of a map' by Brigadier Sir Clinton Lewis (6*d.*); 'Geography and visual education' by G. J. Cons (1*s.*); and 'Air transport and geography' by W. G. V. Balchin (1*s.*). These may still be had on early application to the Office of the Society.

WATKINS AWARD

At a recent meeting of the Committee of Management of the Gino Watkins Memorial Fund, of which the Royal Geographical Society is trustee, the interest being administered by the Scott Polar Research Institute at Cambridge, it was agreed that a sum should be set aside each year to be known as the Watkins Award for polar exploration. Normally the Award would be given to a candidate not of senior status.

The Watkins Award for 1948 of £50 was given to Mr. W. R. B. Battle of Leeds University for an expedition to east Greenland. An additional award of £20 was given to Mr. D. Sergeant of Cambridge University for the purchase of selected equipment for an expedition to Bear Island.

THE RECORD

GRANTS FOR WORK IN NORTH AMERICAN ARCTIC

The Arctic Institute of North America has available a total of at least $5000 for several senior grants-in-aid for scientific work in the North American Arctic and Subarctic during 1949. Research must include field investigations in either Alaska, northern Canada, Labrador, Newfoundland, or Greenland. The grants-in-aid are open to anyone who has demonstrated his ability to carry out research work of superior quality in some field of science. They will be awarded on the recommendation of the Board of Governors of the Arctic Institute and will be announced by March 1949. Applications must be received by 1 November 1948. Application forms may be obtained from The Arctic Institute of North America, 805 Sherbrooke Street West, Montreal, Canada; or Audubon Terrace, Broadway and 156th Street, New York 32, New York, U.S.A.

UNIVERSITY NEWS

UNIVERSITY OF CAMBRIDGE

In the Long Vacation a very successful and enjoyable field meeting was held in Norway. The route included Bergen, Voss, Stalheim, Gudvangen Naerofjord, Sognefjord, Leikanger, Scholden, Turtagro, and Rõysheim. Twelve days were then spent walking in the Jotunheim where Spiterstulen proved a most attractive centre. Several Turiststasjons were visited including Juvashytte, Gjendebu, Leirvassbu, and Krossbu. On our return we travelled by fjord steamer from Leikanger to Bergen. The glaciated scenery of the Jotunheim has much to commend it for reasonably strenuous field meetings, and the Turiststasjons will accommodate a party of thirty or forty excellently with very little notice in the latter half of August.

The 1947–48 session started with an immediate crisis in laboratory accommodation. By 1946–47 the first year numbers had increased substantially above the pre-war figure; this year they jumped a further 30 per cent. to 128, bringing the total number of honours students reading geography full-time to over 280. This year's increase was relatively much greater than that of the undergraduate population as a whole and reflects to a great extent the ex-service men's choice of subject on returning to Cambridge. The university authorities promptly approved two new University Demonstratorships in the subject, but also added geography to the short list of restricted subjects from October 1948. We hope that this will lead to an increase in quality rather than in quantity, but the best

assurance that this will be so is the increasing confidence in geography shown by the colleges. St. John's College, at the instigation of Mr. J. M. Wordie, have introduced geography scholarships, and Trinity College now allow geography to be offered as a subsidiary subject in their scholarship examinations. This means that from 1948 on geography can be offered as a main scholarship subject at St. Catharine's, Selwyn, St. John's, Girton, and Newnham Colleges, and as a subsidiary subject at St. John's, Queens', Emmanuel, Sidney Sussex, Christ's, and Trinity Colleges.

The new St. John's College scholarship examination in geography will consist of the following five papers: Physical Geography and Geology, Political and Economic Geography, Essay, and any two of a wide range of subjects from the General Scholarship Examination.

The award of the Victoria Medal of the Society to Professor Debenham gave us particular pleasure, as did that of the Gill Memorial to Mr. W. W. Williams. Mr. Manley's appointment to the Chair of Geography at Bedford College is also a very natural source of pride and he will go to London with our warmest regards, though we shall be all too aware of the gap his departure will inevitably leave at Cambridge. His nine years at Cambridge have been crowned by the University's forming an influential Meteorological Committee, with Mr. Manley as Secretary, charged with promoting research in, and the study of, meteorology.

Mr. A. A. L. Caesar has been appointed to a University Demonstratorship and will return to Cambridge with wide experience of geography in other fields and as a member of that rapidly growing group of St. Catharine's geographers in university posts. W. V. L.

UNIVERSITY OF GLASGOW

Greatly increased accommodation has been allotted to the Department of Geography in this University, so that in this respect generous provision has been made for the probable needs of many years. The problem of equipment still remains. Sufficient money is available and the problem will be duly solved, but in the present condition of things not immediately.

The supply of students is adequate but not excessive. There is a better balance than there has been between the various stages of the courses. Staffing is a very difficult problem, especially where one tries to be duly exacting in the matter of quality and promise.

For some years a valuable scholarship has been available to encourage alumni to extend their geographical studies at other schools of geography, especially overseas. The first incumbent who has found it possible to go abroad is now at the University of Geneva.

In addition to the private research which is going on continually, the Glasgow school has been engaged cooperatively in carrying out the measurements necessary to specify quantitatively the orography of the country. On the basis of the measurements, which are likely to be completed in the summer of this year, it is hoped to base a series of hypsographic studies which ought to prove fruitful.

The University has promoted an Ordinance for the establishment of a Chair of Geography. The Ordinance received the Royal Assent on November 13 last, and the chair has been filled as from that date. A. S.

UNIVERSITY COLLEGE, SWANSEA, UNIVERSITY OF WALES

Geography at Swansea shares a roof with Geology in a combined Department whose head is Professor Duncan Leitch, Professor of Geology and Geography. The close liaison with Geology favours the construction of a firm physical basis, and a grounding in Geology is made compulsory for all students proceeding to the "Final Pass" stage in Geography. The teaching of Geography itself however

is entirely in the hands of a Lecturer in Geography, Mr. B. H. Farmer, and a Demonstrator, Mrs. M. B. Hopkins.

Second and Third Year courses are provided, the latter of "Final Pass" standard. Students of both Faculties (Arts and Science) may read Geography. There is no First Year ("Intermediate") course; Students enter the Second Year class either straight from school with a Higher School Certificate in Geography or from First Year courses in other subjects which must include Geology. There is as yet no Honours course in Geography at Swansea but the question is under discussion.

Student numbers are now, as in so many schools of Geography, somewhat overwhelming. Between the 1946–47 and 1947–48 sessions, the numbers in the Second Year (Subsidiary and First Year Final) increased from 30 to 51; in the Third Year (Second Year Final) from 17 to 21: thus the total increase was from 47 to 72 students.

Some experimental recasting of courses is at present in progress, but the general pattern is clear. It emphasizes principles and methods of attack in the Second Year course, and applies these principles and methods to a series of regional studies in the Third, "Final" year. The value of practical and field work is strongly stressed throughout, and a field week for Third Year students is held during the Easter vacation. B. H. F.

COMMITTEE ON THE REVIVAL OF BRITISH GEOGRAPHY

At the Dundee Meeting of the British Association, 1947, Section E recommended the appointment of a committee of the Section to collect information on the revival of British geography from around 1880 and on the persons connected therewith. It was felt that unless such steps were taken now while some of the pioneers are still alive a great opportunity of recording the most important phase in the history of British geography might be lost for ever. G. G. Chisholm, A. J. Herbertson, L. W. Lyde, H. J. Mackinder, Marion I. Newbigin, Ll. Rodwell Jones, P. M. Roxby—to mention only some—are all dead and of none is there an adequate appreciation in print or even a detailed statement of their services to geography. Many of the younger generation of geographers regard the task of collecting information as both a duty to posterity and a tribute to the pioneers. The response to the request for data has been encouraging though so far it has been circulated only to some of those most intimately connected with the generation of geographers recalled by the names listed above. Suggestions and contributions from any who may be interested should be sent to the Secretary, T. W. Freeman, Department of Geography, Trinity College, Dublin. T. W. F.

GEOGRAPHY IN PUBLIC AND PREPARATORY SCHOOLS

With the gradual increase in the number of University Scholarships in geography, many Public Schools will be following the lead of the few and making it a separate specialist subject in post-Certificate work. Some may develop it in the lower forms and even follow the suggestion made by one head master to make geography the central subject in a curriculum and let it supersede Latin for those who do not require that subject. Whatever form this development may take, the days of a broader physical basis, of practical and field work, and of a realistic and practical approach to economic and regional geography—all with the central theme of Man—have arrived. Short as their time is, Preparatory Schools are similarly making their geography less theoretical.

Working through its Public and Preparatory Schools Group, the Geographical Association is giving practical help and encouragement to this movement.

Formal and informal discussions during the Group's annual Field Week and Refresher Course (Cambridge 1947, Cotswolds 1948) are facilitating the exchange of ideas and methods of teaching by geography teachers from both types of schools in all parts of the country. In addition the Group lends slides, books, and information of other kinds, and publishes a small gazette once or twice each year. Those wishing to know more about the Group and its work are invited to write to the Secretary, Mr. Antony Constant, at Rugby School. A. C.

INTERNATIONAL PHOTOGRAMMETRY CONGRESS AT THE HAGUE

The Sixth International Photogrammetry Congress will be held at The Hague from 1 to 10 September 1948. The Congress will include sections for Photography and its techniques; Plotting (theory, means and results); Aerial triangulation and its application in geodesy (including electronic methods); Application of photogrammetry and aerial photography for surveying the earth's surface; and the application of photogrammetry in various spheres. The programme of sessions has been arranged so that whenever possible the main sections will meet at different times, to allow all who are interested to attend. An exhibition will be open throughout the Congress, and a number of excursions have been arranged. Further particulars about the Congress, including terms, may be obtained from the Society. Applications should be sent as soon as possible to the Secretary-General, Mr. B. Scherpbier, van Voorschotenlaan 9, The Hague.

JOURNAL OF THE INSTITUTE OF NAVIGATION

The first number of the *Journal* of the Institute of Navigation, which was formed under the aegis of the Society, appeared in January and will be welcomed by all who are interested in the science and art of navigation. It contains the opening address of the first President of the Institute, Sir Harold Spencer Jones, F.R.S., Astronomer Royal, followed by inaugural contributions from distinguished persons prominent in navigation and science. There are then several papers on technical matters by recognized authorities, and finally space is allotted to the Record of the Institute, Reviews, and Correspondence. The *Journal* is notable as being the first of its kind, and for the high standard of its typography and general appearance.

The President in his address informs us that "The Institute of Navigation has been formed to promote the interests of science and of practical navigation, by uniting together in a scientific body those who are concerned with or are interested in the science and art of navigation . . . it will therefore include within its membership the scientist, the practical navigator and the designer and manufacturer of navigational equipment. But membership is not to be restricted to those who are, so to speak, professionally concerned in one way or another with navigation. It is open to all who are interested in the problems with which the Institute will deal and who desire, through its membership, to assist in the promotion of the science and art of navigation." An interesting summary is given of the development of navigation since 1675, when the Royal Observatory was founded, and the address closes with messages from the First Sea Lord and the Chief of the Air Staff.

Sir Robert Watson-Watt in his article "Radio aids to navigation" tells us something of what can and, equally important, what cannot at present be expected from the various aids and gives us his views on how their use is likely to develop. D. H. Sadler, Superintendent of the Nautical Almanac Office, contributes a paper on "Altitude corrections for coriolis and other accelerations" and their practical application. A. H. Jessell gives a very clear explanation of

Consol. Four papers by Squadron Leader D. O. Fraser (Technical Secretary of the Institute), Flight Lieutenant L. F. Banks (Empire Air Navigation School), J. S. Sawyer (Meteorological Office), and E. W. Pike (B.O.A.C.) describe the theory and art of pressure pattern flying and its practical application. F. Chichester has an interesting paper on "What is the ideal air map?" which should help to clear our minds on the subject.

A summary of the conclusions and recommendations of the second International Meeting on Radio-Aids to Marine Navigation and two reports from the International Civil Aviation Organization are given, followed by a description of the new Ocean Weather Service and two short articles on the "Navigational aspect of flight refuelling" and "Navigation in automatic flight."

The *Journal* is published quarterly and is obtainable from John Murray, 50 Albemarle Street, W.1., price six shillings. The postal address of the Institute is at the Royal Geographical Society. A. G. N. WYATT

FALKLAND ISLANDS DEPENDENCIES SURVEY, 1947–48

During the 1947–48 season the two main bases of the Falkland Islands Dependencies Survey, at Hope Bay and at Stonington Island in Marguerite Bay, completed one of the most successful year's work recorded in the recent history of antarctic sledging. Some 3500 miles were covered by dog team and extensive topographical and geological survey work was carried out in the Dependencies. The year's sledging culminated in two long summer journeys which resulted in the survey of 1050 miles of the Weddell Sea coast of Graham Land, much of which had never before been traversed by ground parties and had never been accurately charted.

A party from Hope Bay consisting of F. K. Elliot (leader), S. J. Francis (surveyor), M. A. Choyce (meteorologist), and R. J. Adie (geologist) travelled southwards down the Weddell Sea coast to a rendezvous, 500 miles south of their base, with another party travelling north-eastwards across the plateau from Marguerite Bay. They reached Stonington Island on January 5 after 71 days in the field, during which time approximately 620 miles had been covered, including 80 miles in relaying stores over poor surfaces and collecting rock specimens from the coast. During this journey the main features of the east coast of Graham Land and its off-lying islands were surveyed.

The second party was supported by air from Stonington Island on its journey southwards down the Weddell Sea coast. This was a combined British and American sledging party using all-British dog teams and equipment. At the start it consisted of D. P. Mason (leader and surveyor) and Dr. A. R. C. Butson from the British base, with A. Owen (dog driver) and N. McClary (assistant navigator) from the Ronne Antarctic Research Expedition. During and after the crossing of the plateau some of the men were exchanged by air. A hundred and fifty miles from base the party responsible for the main journey had become K. S. P. Butler (leader) and D. P. Mason from the British base, with two Americans, W. H. Smith (assistant navigator) and A. Owen. E. A. Wood and A. A. Thompson from the American base also took part in the earlier stage of this journey. Originally planned to start at the end of September, the journey was delayed because of the loss of a British Auster aircraft 120 miles south-east of the base while on a depot-laying flight. The total distance covered on this journey was 1190 miles, completed on January 20 after 97 days in the field.

A complete photographic panorama of the coast was recorded on both journeys, and thirty astrofixes were taken. Ground control was provided for the air survey carried out by the Ronne Antarctic Research Expedition between latitudes 66° 30′ and 75° S. B. B. R.

CLIMATE OF THE LAKE ALBERT REGION

Information about the climate of the physically complex and highly picturesque western Rift Valley is somewhat meagre, so that an article by J. M. Meesen on the climatology of the Congo region to the west and south of Lake Albert is especially welcome (*Bull. Agricole du Congo Belge*, 38 (1947) 583–605).

The author utilizes data from meteorological stations at Kilomines, Nioka, and Iruma as well as from a number of rainfall stations, and describes in an interesting manner his observations of the local conditions from personal experience. The influence upon the weather of such major natural features as the valley of the Semliki river which flows down from Ruwenzori towards Lake Albert, the lake basin itself, hemmed in especially on the western side by lofty mountains, and the vast forests of the Ituri valley is very definite; but the full evaluation of these local factors is rendered difficult because of the lack of precise knowledge concerning the general wind system in this region. Thus previous writers neither agree among themselves nor with Meesen's own observation concerning the predominance at various seasons of the year of one or other of the three principal air currents, namely the North-East Trade, South-East Trade, and the Egyptian current. The discrepancy is no doubt accountable to the fact that the Lake Albert region lies along the inter-tropical front with conflicting air currents, so that investigation over a long period of years would be necessary to show the average trend of the wind system. This supposition of great year-to-year variability is supported by the difference in the length of the dry season at a place called Kwandruma, which in the decade 1935–45 was as short as 15 days in one year and as long as 135 in another.

The temperature is only oppressively high in the Semliki valley and along the shores of the lake where its altitude is below 2000 feet. It is quite moderate—below 70° F.—over much of the area where the altitude is between 3000 and 4000 feet, and exhilaratingly cool on the high summits along the Nile–Congo watershed. The mean annual range is exceedingly small, only about 3° F., being highest in March and April and lowest in July. As the region lies near the equator the solstitial periods are cooler than the equinoctial, though since the actual latitude is about 2° N. it is somewhat anomalous to find July cooler than January. The latter month however is in the major dry season which may explain the anomaly. Nocturnal cooling is intensified and prolonged in the deep mountain valleys where heavy dews, fogs, and even damaging frosts induced by air drainage occur.

Rainfall is heavy, 50 to 100 inches a year according to locality. The influence of Lake Albert upon the rainfall is considerable. After clear mornings heavy cumulus clouds commonly develop over the lake and are driven by the prevailing easterly trade winds towards the western shore where they are forced upwards with heavy precipitation on the forested Congo–Nile watershed. On the lee side of this watershed foehn winds occur with localized patches of xerophytic vegetation.

Thunder and hailstorms are particularly frequent and violent at the time of the autumnal equinox which coincides with the major wet season. The author points out what has also been noticed in parts of France, that certain kinds of rock are more liable to be struck by lightning than others, and that damage often occurs in places situated along the junction of different geological formations. Whether or not the effect is connected with differences in radio-activity and ionization of the air, the subject opens out an interesting and important line for research in all countries where thunder-storms are at all obtrusive. Hail, though infrequent near the lake, is abundant on the plateaus and mountains, and does long-lasting damage to crops.

Rain does not entirely fail even during the chief dry season, and during the wetter seasons may fall heavily for four or five consecutive days. Occasionally such very wet spells embrace the whole of the north-east Congo State, but more usually they first affect one locality then, after an interval, another according to a pattern which remains to be investigated in detail. L. C. W. B.

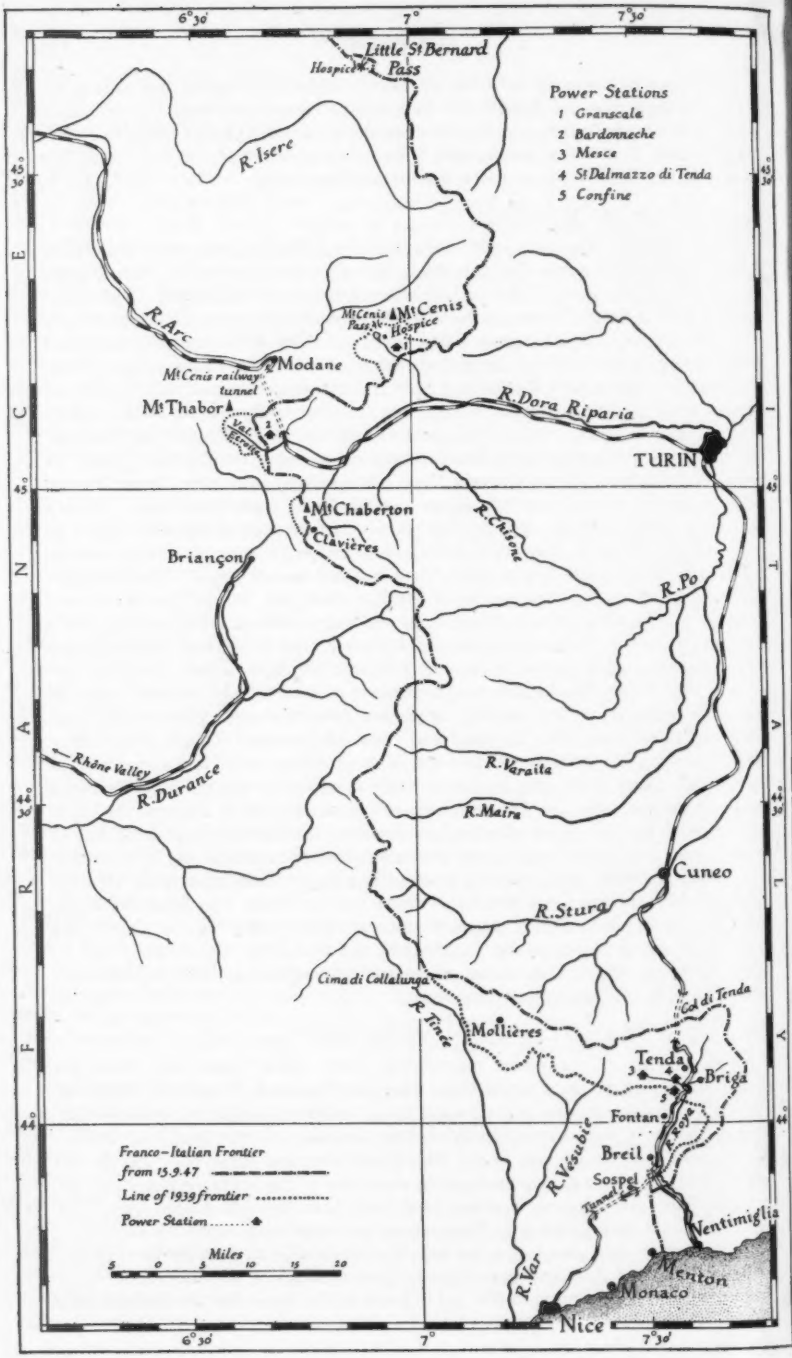
NAMES GIVEN BY COOK

In his 'Life of Captain Cook' (London, 1939) Hugh Carrington said "New South Wales is the name that appears in the official copy of his Journal, though he uses the name New Wales in the holograph journal in Sydney. There was already a New South Wales on the map of the world—the south-western shores of Hudson's Bay. It is suggested that the name New Wales came to his mind from the appearance of M. de Brosses' map of which he made so much use, whereon the names New Britain and New Ireland would suggest New Wales to a person who was seeking a name" (p. 170, footnote). By M. de Brosses' map Carrington evidently meant the plate numbered I in Charles de Brosses' 'Histoire des Navigations aux Terres australes' (2 vols., Paris, 1756), which he reproduced in his 'Life of Captain Cook'; but neither on it nor on de Brosses' Plate V, which shows New Britain on a much larger scale than Plate I, does a name for New Ireland appear. Not until Carteret sailed between them in September 1767 were New Britain and New Ireland known to be two islands. Up to the time of his first voyage Cook had no knowledge of Carteret's discoveries, for Cook left England on 26 August 1768 and Carteret did not return until 20 March 1769. Carrington's suggestion nevertheless is not empty. With the Dutch names Nieuw-Holland and Nieuw-Zeeland and the English name New Britain already in use within the range of his explorations, it is not surprising that Cook should follow a precedent at least as old as early Spanish maritime exploration, by naming large new countries after parts of his own country. The names New England and New Albion were occupied. He chose New Wales on his first voyage and the New Hebrides and New Caledonia on his second, naming the last, it seems, without regard to the existence of Nova Scotia. Carteret called his discovery Nova Hibernia *or* New Ireland. As Cook discovered New Caledonia after he had explored the New Hebrides, neither of these names may have been given spontaneously. It is interesting to note that the names Australie and Australasie and the adjective australien were all used by de Brosses, though Cook may hardly have noticed them. The form Australia, referring to Espiritu Santo, appears once in the journal of Cook's second voyage ('A voyage towards the South Pole and round the world, etc.,' vol. 2, p. 24, London, 1777). The name of Australia however has been exhaustively treated in 'The Australian encyclopaedia.' M. A.

THE NEW FRANCO-ITALIAN FRONTIER

By the terms of the peace treaty with Italy which came into force on 15 September 1947, the Franco-Italian frontier has been changed in favour of France in five areas. France claimed these areas primarily to improve her frontier defences and communications, but she has also obtained four hydro-electric power stations—one in the Mt. Cenis area and three near Tenda. In return, Italy has been guaranteed power generated in these stations and the use of water from rivers rising in those areas and from the Mt. Cenis lake. The five zones now incorporated in France are, in order from north to south:

(1) A narrow strip about 3½ miles long by ¾ mile wide to gain the crest of the Little St. Bernard Pass and bringing the famous Hospice within France. The French waived their claims to the Val d'Aosta in the hope that the Italians will


6°30'
7°
7°30'
Little St Bernard Pass
Hospice
Power Stations
1 Granscala
2 Bardonneche
3 Mesce
4 St Dalmazzo di Tenda
5 Confine
R. Isere
R. Arc
Mt Cenis Pass
Mt Cenis Hospice
Modane
Mt Cenis railway tunnel
Mt Thabor
Val Cenischia
R. Dora Riparia
TURIN
Mt Chaberton
Clavières
Briançon
R. Chisone
R. Po
Rhône Valley
R. Durance
R. Varaita
R. Maira
Cuneo
R. Stura
Cima di Collalunga
R. Tinée
Mollières
Col di Tenda
Tenda
Briga
Fontan
R. Roya
Breil
R. Vésubie
Sospel
Tunnel
Ventimiglia
Menton
R. Var
Monaco
Nice
Franco-Italian Frontier from 15.9.47
Line of 1939 frontier
Power Station
Miles
5 0 5 10 15 20
45°30'
45°
44°30'
44°
ALPES MARITIMES
PIEDMONT

grant special rights to the French-speaking communes in that valley. (Map references: St. Foy Tarentaise 1:20,000 1–2 and also 1:50,000.)

(2) A block of country roughly 6 miles square immediately south of the Mt. Cenis Pass and including the Mt. Cenis plateau grazing lands which have long belonged to French families in French villages. The Italians prevented the French from using these lands after 1936. France gains the Mt. Cenis plateau, the lake, and the Granscala hydro-electric power station. The new frontier is about one-half the length of the former one. (Map references: Lanslebourg 1:20,000 5–6, 7–8, and Mt. d'Ambin 1–2. Also Lanslebourg 1:50,000.)

(3) A pear-shaped wedge of country, maximum extent 9 miles by 4 miles, south-east of Mt. Thabor and west of the Mt. Cenis railway tunnel. The reservoirs feeding the Vallée Etroite hydro-electric power station are left in Italy. (Map references: Névache 1:20,000 1–2, 5–6, 7–8 and also 1:50,000.)

(4) A narrow piece of territory in the Mt. Chamberton region and immediately west of Clavières, the latter village remaining in Italy. In connection with this and the previous frontier change, the Italians must allow the French, if they so desire, to construct across Italian territory a railway linking the Rhône valley–Briançon line with the Paris–Mt. Cenis–Turin line, as also a road from Briançon to Modane. Such new communications would be of great benefit to Briançon and would link the northern and southern Alps of France, to the great advantage of the south and of the French Riviera. This change will also remove the frontier sufficiently to the east to cause Briançon to be no longer overlooked by an Italian fort. (Map references: Briançon 1:20,000 3–4 and 1:50,000.)

(5) The only really large or very significant change gives France the upper waters of La Tinée, La Vésubie, and La Roya north of Menton on the Mediterranean. From the Cima di Collalunga to east of Tenda and Briga the area gained by France averages 32 miles from west to east by 6 miles from north to south. This wedge is continued south-east of Briga by a narrow strip about 10 miles long from north-east to south-west and about 1 to 2 miles wide. These changes give to France the communes of Tenda and Briga and three more power stations. These are at Mesce and Confine which serve the Italian State Railways, and at St. Dalmazzo di Tenda which serves Genoa and was damaged by the Germans. The French power stations at Breil and Fontan were wrecked and, until these are rebuilt, the three former Italian plants will be used by the French for supplying power to the French towns of Sospel, Menton, Nice, and so on. Excess power will be made available to Italy. France and Italy are to develop a coordinated plan for the full and equitable utilization of the Roya and its tributaries for hydro-electric power.

The new frontier runs along the main crest of the watershed through the Col di Tenda, and a considerable stretch of the railway from Turin *via* Cuneo to Breil (where it branches to Ventimiglia and Menton) is gained by France.

Until 1860 the area now gained by France in this fifth sector had formed part of the County of Nice, which was then ceded to France. But Napoleon III waived his claim to the head of the passes and returned the districts west of Briga and Tenda to Italy so that Victor Emmanuel II could retain his favourite hunting grounds in the upper Tinée and Vésubie. Hamlets such as Mollière speak a French dialect and in winter were always dependent upon France, since they were cut off from Italy by the snow-capped mountain watershed. They are now incorporated in France, like the rest of the County of Nice. By a referendum held on 12 October 1947, 2603 of the inhabitants voted for France and 218 for Italy, but it must be noted that the territory had already been attached to France. Tenda is by majority Italian and Briga by majority French, but a frontier based only on ethnographic considerations would be unsatisfactory. In any case the

reason for the changes was strategic and to enable the French to hold all the crests after the painful experience of 10 June 1940. The changes have brought about 7000 people within France, three-quarters of whom live in Briga and Tenda. There are very few inhabitants in the other four sectors. (Map references: St. Etienne de Tinée 1:20,000 3–4, 7–8 and 1:50,000. Les Trois Ponts 1:20,000 5–6 and Italian Madonna delle Finestre, Colle di Tenda and Certora di Pesio 1:20,000. French Pointe de Lugo 1:20,000 1–2, 5–6; San Remo 1–2; Menton 3–4; and French St. Martin-Vésubie and Puget Théniers 1:50,000.)

The only significant economic value of all five sectors lies in developed and potential hydro-electric power. Detailed provisions have been made for collaboration in these matters by agreements concerning the trans-frontier supply of power at agreed rates, the free flow of water, and the supply of information on levels and rates of discharge. Italy can require the use of pumps at the Mt. Cenis lake to maintain its level, and the agreement to develop power jointly in the Roya valley is a hopeful scheme. The effect of the changes numbered (1) and (5) is to put the frontier at the watershed and of numbers (2) to (4) to take France over the watershed. The essential factor throughout is strategic.

R. J. HARRISON CHURCH.

OBITUARY

JAMES LAWRENCE CHAWORTH-MUSTERS

Mr. J. L. Chaworth-Musters died suddenly on 12 April 1948, at the early age of forty-six. He was the youngest son of the late Mr. and Mrs. J. P. Chaworth-Musters of Annesley Park, Notts. He was educated at Rugby and Cambridge, where he read geography and took up the study of natural history, especially mammals and birds. Between 1920 and 1929 he took part in collecting expeditions to Jan Mayen, Cyrenaica, Greece, the High Atlas, Morocco, and Afghanistan, apart from frequent visits to Norway where he had an estate in the mountains. During the war he served as a lieutenant in the R.N.V.R. and did valuable work in connection with operations in Norway.

He was closely associated with the British Museum (Natural History) for the past twenty years as a voluntary worker in the Mammal section of the Department of Zoology, except for a short period as temporary assistant-keeper. The systematic study of mammals occupied most of his time and he made important contributions to our knowledge of Palaearctic rodents. He was particularly interested in the mammals of Scandinavia, and visited the museums of Leningrad and Moscow in the course of preparing an extensive check-list of Palaearctic mammals.

He joined the Society in 1921 and was perhaps best known to members of the Geographical Club. He liked to express his opinions freely and was very outspoken, but with his keen sense of humour and cheerful disposition he could make friends quickly with all classes of men. By his untimely death we have lost a keen and enthusiastic traveller and naturalist whose absence will be felt by a wide circle of friends.

E. H.

CORRESPONDENCE

THE RELATION OF GEOMORPHOLOGY TO GEOGRAPHY

Arising from the fact that Dr. Strøm's lecture on the geomorphology of Norway was of little genuine interest to geographers—and ought, in my opinion, to have been read before a society of geologists or geomorphologists—and that Mr. Seaborne's letter in the current *Journal* (110 (1947) 261) purports to deal with the subject of defining geographical terms, it seems to me about time that a stop was put to much muddled thinking and practice (particularly the latter) on the relationship of geomorphology to the field of geography. A "pre-Cambrian erosion surface" is not a geographical term at all; nor are Mr. Seaborne's "escarpment" and "cuesta" geographical terms. The fact that many geographers in this country are using geomorphological terms as geographical ones is symptomatic of the confusion of thought. Soon possibly we shall read that "geographically" the North Downs are a "cuesta" or "escarpment." Surely the question of what a cuesta is or is not is for the geomorphologist to decide. The tragedy of the situation is that German geographers resolved the problem of confusion between geomorphology and geography twenty odd years ago: perhaps we shall learn our lesson in time. Professor Wooldridge alluded to the "Palaeozoic squint" of British geomorphologists; he might also have alluded, I think, to the "Davisian squint" of some of our geographers and certain of our schools of geography.

Not that I would deny the use of the geomorphologist's terminology as a starting point for the geographer, so long as he realizes that the terms he is using for his classification or description of land-forms are those of another science. Unfortunately it is the practice of many of our schools of geography to teach the geomorphologist's genetic concepts of land-forms which have no function whatsoever in the field of geography. For example, the evolution of the drainage and land-forms of the Weald is a legitimate part of the geomorphologist's science, but of what use is a knowledge of the Middle Tertiary phase in the evolution of the Weald to a geographer concerned only with the present reality of the area as regards relief?

The traditional link between geography and geomorphology in this country dies slowly if at all. The influence of W. M. Davis in this country has meant that academic geography has—apart from certain notable exceptions—stood still in the most important fields of the subject—the regional and economic ones. It is time geomorphology was adopted by the science of geology to which it is more intimately related: geographers have foster-mothered it long enough.

21 *April* 1948 D. E. SEWELL

GEOGRAPHY AND ITS COMPONENTS

The Editor has been most generous in the space allotted to the correspondence which resulted from my letter in the *Geographical Journal* (107 (1946) 272–3) of more than a year ago. What I wrote was a virtual challenge to those who customarily employ the term "Human Geography" reluctantly in default of a better, because more adequate, term; to those—the vast majority—who take the term for granted as acceptable, without investigating its credentials; and, yet again, to those who, more positively, regard it as scientifically satisfactory. To the latter small and, I hope, dwindling group I ventured my view that the

continued use of the term was an illiteracy which should be corrected by those who are the custodians and protectors of geographical standards. From this latter group I expected an enthusiastic defence of the legitimacy of "Human Geography," but no such defence has been offered. The most that has been said on its behalf is that in a rough and ready way we geographers understand what is meant; and, by implication, that it is good enough for our unprecise purposes that this mistranslation of "la géographie humaine" should remain the most frequently employed technical term in our geographical vocabulary. If that is all that can be said on its behalf then some of us will be resolved more than ever to avoid its use. It is my conviction that the terms we use in defining our concepts must be fully adequate to satisfy examination not only by the more thoughtful of our students, but also by those interested colleagues in other sciences who, not infrequently, charge us with unscientific habits. And knowledge of philology does not need to be profound to furnish criticism of "human" as the adjective of "geography."

I welcome Professor Wooldridge's acceptance of my suggestion that "Social Geography" is, by definition, the most suitable term to embrace all those aspects of geography which place the latter among the humane studies; and, in recognition, I would urge that for his admitted ignorance of the ritual of Social Geography as practised in the northern zone of the realm a generous absolution should be extended to him. I think Social Geography as defined by the late Professor P. M. Roxby (Presidential Address, Section E, British Association, 1930) will continue the notable development which he initiated, whatever *omnibus* term we choose to replace the unfortunate and—I think—discredited term "Human Geography." Excessive emphasis on the study of Economic Geography, treated with a strong flavour of materialism, was the occasion of Roxby's eloquent appeal for a more humanistic outlook in geography and, in particular, for recognition of the place and contribution of Social Geography. But here Roxby was thinking of "Social Geography," not as Wooldridge is prepared to employ that term but as merely one constituent of the group which includes also the political, economic, and historical aspects of geography. At Manchester a general course in Social Geography along lines which would have recommended themselves to Roxby has been offered for some time, and it would be interesting and valuable to be able to compare notes with any other geography school which is experimenting in a similar direction.

There seems to be widespread assent to the brief, general statement in my first letter on the purpose and method of Historical Geography. Professor E. G. R. Taylor makes the claim that most of our modern literature in this field satisfies its aims of reconstructing and interpreting the geography of past periods. Investigation of the published work of the same authorities as those she cites has long led me however to a very different conclusion; and it is my view that, as stated previously, much of what in Britain to-day passes as Historical Geography is economic history with just sufficient geographical trimmings added to make its disguise plausible. For the uncritical and unwary student of Historical Geography, economic history has a quite fatal fascination; it seems to offer ready-made material which lends itself to a counterfeit of Historical Geography. If students are to be given a model of what Historical Geography can be I should prefer them to follow Grenville A. J. Cole in his inspired little study 'Ireland the outpost,' or Halford Mackinder, of illustrious memory, in his chapter on "Historical Geography" in 'Britain and the British Seas.' Neither of these dependable prophets is ever distracted from his compelling interest in "place" to an undue interest in man's activities, more suitable to the ethnologist, the archaeologist, or the historian.

Sir C. F. Arden-Close's much-appreciated support of my contention of the need for a clear distinction between Historical Geography and the history of geography provides the mournful evidence that at various International Geographical Congresses of recent years these two subjects of widely different disciplines have been confused, one with the other. In concluding this letter I should like to thank all the other colleagues who have joined in the discussion; and, if I may single out one contribution from many, it is to welcome Mr. Tom Harrisson's appeal for cooperation between geography and sociology in the field of Social Geography, for which cooperation he predicts a most promising future.

WALTER FITZGERALD

26 *January* 1948

CALLIGRAPHY ON EARLY MAPS

May I correct a misleading statement by your reviewer of 'Catalogue of maps in the Essex Record Office' (*Geogr. J.* 110 (1947) 229). Describing plans drawn by Israel Amys in 1576 to illustrate one of his written manorial surveys, "E. G. R. T " notes that he used the same writing hand for his maps and his text, and then adds that this "disposes of Dr. Lynam's suggestion in his foreword that the early surveyors studied and copied the lettering on copper-plate maps."

What I wrote was: "after 1591 . . . draughtsmen had begun to imitate closely the style of the published maps of large areas . . . they copied in manuscript the delicate art of the copper engravers." Your reviewer has overlooked my limiting date, important though it is, and my "begun." She has interpreted "style" and "manuscript" as meaning lettering, although two sentences later on I gave a different origin for lettering on maps. And Amys' maps, apart from their date, are not of large areas but are small plans of holdings inserted in his survey-book. No surveyor would waste fine handwriting on such plans. Even if these had come within my period and my category they would not have "disposed of" all that I wrote. A general statement covering numerous examples is not disposed of by the production of a solitary exception.

EDWARD LYNAM

11 *April* 1948

FOOD FOR AN EVEREST EXPEDITION

I am not a mountaineer but have had some experience of travel in Tibet. In my early days, before I was married, I never troubled much about food and lived largely on tinned food besides local supplies. Marriage however changed all that. My wife considered it inefficient housekeeping to open a tin at all! In Tibet you can nearly always get sheep; so, in our travels there, mutton was our chief protein ration. Then you can usually get milk. Yaks were brought into our camp daily to be milked or, if this was not possible, our servants would take our own milk pails and get the yaks milked into them. Tibetan receptacles are always very dirty. The milk was set in pans, giving us cream and butter the next day. We used no tinned butter. Tibetan butter has flavours which we disliked. Bread and biscuits were baked en route each day. We also carried a few tins of biscuits, especially water biscuits, which were very useful in cases of mountain sickness. We found that the best way to deal with this terrible complaint was to nibble very dry biscuits or thin toast and sip hot, weak tea with no milk or sugar, also to take aspirin for the headache.

On our annual trips from Sikkim to Gyantse we had vegetables specially grown for us both in the Chumbi valley and at Gyantse. On more ambitious

and distant journeys we had these vegetables carried by the men who brought us our post, so that we had fresh green vegetables every day. Speaking from memory, the only things we carried were potatoes, onions, bacon, a ham, flour, tea, coffee, sugar, salt, etc., besides a few luxuries. We found that for lighting, unlimited candles with glass globes were simpler, cleaner, and in every way better than oil or petrol.

I always insisted on a tin or two of iron rations but in seven years these were never used and at the end of each trip had to be consumed on our return home. These rations consisted of tinned meats, tinned milk and butter, and plum pudding.

I suggest that for an Everest expedition vegetables should be grown in the Arun or some other adjacent valley and a load of these carried up to the base camp every few days. They would have to be grown at sufficiently low altitudes to ensure their being ready in time. They might even be started under glass as ours were at Gyantse. I think that when at the base camp men should be fed on fresh food in this way. I say nothing about the concentrated food necessary for the climbers when on the mountain and when every ounce of weight is all important.

A first-class cook should be taken, preferably a European—French, Swiss, Tyrolese, or Bavarian would be suitable if accustomed to mountains; failing this a really good Indian hillman might do. A climber coming off the mountain with the prospect of a first-class meal at the base camp would have a moral advantage. On one Everest expedition we learnt that the cook was paid less than our own cook who had a permanent and comfortable job in Gangtok.

These suggestions only apply to a large expedition organized on the Everest scale.

Once we travelled for four months in Bhutan and Tibet. The mess consisted of eight people. Parts of the country were unexplored and uninhabited. It was not an easy journey: roads were bad and one pass of 17,400 feet with glaciers had to be crossed, yet we had fresh vegetables, meat, and dairy produce all the way. The vegetables were carried for more than a fortnight from where they were grown.

I am not suggesting that an Everest expedition should be conducted on the lines of the small, compact camp of a Political Officer's tour, but I think that the above remarks may give ideas which might be usefully considered when arranging another attempt on Everest.

F. M. BAILEY

28 *April* 1948

W. S. LEWIS MEMORIAL FUND

The undersigned would like to bring to the notice of all old students of the Geography Department, University College, Exeter, the information that an appeal has been launched for a W. S. Lewis Memorial Fund. It is hoped to devote the proceeds to an object which will offer some concrete benefit to students, such as a book prize, or a special section in the Roborough Library, or even a travelling scholarship. The committee confidently invites subscriptions from old students of the department. Contributions to the "Lewis Memorial Fund" should be sent to Mr. A. H. Shorter, Geography Department, University College, Exeter. The committee would also welcome names and addresses of old students known to readers of this notice.

14 *May* 1948

D. B. BARTLETT (Hon. Sec.), R. J. HOOKWAY, ETHEL PATTERSON, R. H. PLAYLL, F. W. MORGAN, A. H. SHORTER (Hon. Treas.)

MEETINGS: SESSION 1947–48

Eighth Meeting, 2 January 1948. Sir Harry Lindsay, Vice-President, in the Chair

Paper: The water resources of Central Africa. By Professor Debenham

Ninth Meeting, 12 January 1948. The President in the Chair

Elections to Fellowship: Syed Safir Uddin Bashir Ahmad; Gerard L. Alexander; Mrs. Violet de Vere Allen; Miss Christine Bryant Bolt; John Wentworth Cook; Miss Dorothy Dearden; Miss Phyllis Marion Dicks; I. Oliver Evans; Captain James Morgan Evans, M.C.; John Evelyn; James Maxwell McConnell Fisher, M.A.; Cecil Griffith Forster; Mrs. Nannie Hadfield; Colvill Joseph William Gordon Hall; Miss Joyce Isabel Hill; David Ernest Jarvis; Air Chief Marshal Sir Arthur Longmore, G.C.B., D.S.O.; Henry John Lowe; Miss Kathleen Margaret Audrey McGill; Drury Albert McMillen, PH.B.; S. C. Mathur, Captain Conrad Eckstein Miller-Brown, B.A., R.A.E.C.; Charles Dunham Ponder; Kenneth Oates Schofield; Derek Michael Sharman; William Showers; Percy T. Silley, B.SC.; Walter Wakefield, M.SC.; Claude Ronnelle Weber; William John Wendelken; Martin Henry Leigh Whitehouse, M.A.; Major H. E. Wilson, B.SC.

Elections to Associate Membership: Miss Sheila Dawson; I. A. D. Gordon; J. J. Percy; R. J. N. Sidney-Woollett; Andrew Murray Sneddon; Richard Yorke Stratton; Alexander Duncan Nicholas Vickers

Paper and Films: New explorations on Jan Mayen Island. By Mr. A. J. Marshall

Tenth Meeting, 26 January 1948

Films: Ekutuleni, place of peace. Kodachrome films with commentary by Mr. Jens Bjerre

Eleventh Meeting, 16 February 1948. The President in the Chair

Elections to Fellowship: Ronald James Acutt; Israel Sunday Ajayi; Charles Armour; Osman Abdul Azis; John Barraclough; Jens Bjerre; George Boex, B.SC.; Miss Rhoda Mary Bousquet, B.A.; Miss Ida Bowes; Malcolm G. Bowman; Denis Hardie Brown, B.A.; Alec Brozel; Philip Francis Buckley; Dennis John Cadman, B.SC.; Michael Joseph Carlson; Stanley Edward Cherry; William Alwin Cooper, B.A.; John David, B.A.; J. G. Davidovics; George Allan Dunn; Miss Eva Dutton; Frederick George Emmison, F.S.A., F.R.HIST.S.; Mrs. Florence Elizabeth Farrar; Geoffrey Walker Firth, B.A.; Norman James Foy, B.A.; Major R. L. France; James Fraser, M.A.; William George Ashley Gibbs; Miss Joan Elizabeth Hankin; Alex Hay; Max Victor Haybrook; H. Heap; John Sinclair Hewitt; Miss Evelyn Margery Hinds; Wilfrid Hitchcock; Peter H. Hoskings; Forbes Andrew Hoyle; Mrs. Dorothy Wayman Hudson, B.A.; Edward W. Hutton; Ernest Walter Jacob, B.SC.; Sgt. Horace Jacques; Captain Peter Le Fleming; Doctor Roberto Levillier; Frederick Naylor Lewis; Miss Dora Little; William Lockhart; William Laird McKinlay; William Charles Middlebrook; John M. Mogey, M.A.; B.Q.M.S. M. G. Mullen; Oliver William Newport; Donovan Howard Pirkis; Alfred George Potter, B.A.; Professor Malcolm Jarvis Proudfoot, M.S., PH.D.; Miss Ellen Grace Reeves, B.A.; Commander G. B. Richey, D.S.C., R.N.V.(S)R.; Heber Joseph Rider; Miss Jean Roberson; George W. A. Rodger; William Kesteven Roots; John Sagar; Michael Gordon Spicer; Jack Timewell; The Rev. Kenneth Edwin Ward;

John Frederick Watts-Fraser; Miss Winifred Kathleen Welch; Henry Woolliscroft West; Donald F. White; Gordon Tredinnick Whiteside; Denis O. P. Woodgate; George Raleigh Gray Worcester; Major D. A. Young

Elections to Associate Membership: Miss Hilda Joyce Byles; Miss Joan Hailey; Frank Kenworthy; Edwin Alexander Mornard; Miss Gwendoline Ethel Steel; Miss Margaret Joy Theaker; Miss E. Mary Thomas

Paper and Films: The Danish expedition to Pearyland. By Mr. Ebbe Munck

Twelfth Meeting, 23 February 1948. Lt.-Colonel Sir John Chancellor, Foreign Secretary, in the Chair

Paper: The middle people. By Mrs. J. A. Steers

Thirteenth Meeting, 8 March 1948

Films: As seen by France. French documentary films with sound commentary.

Fourteenth Meeting, 22 March 1948. Mr. J. A. Steers in the Chair

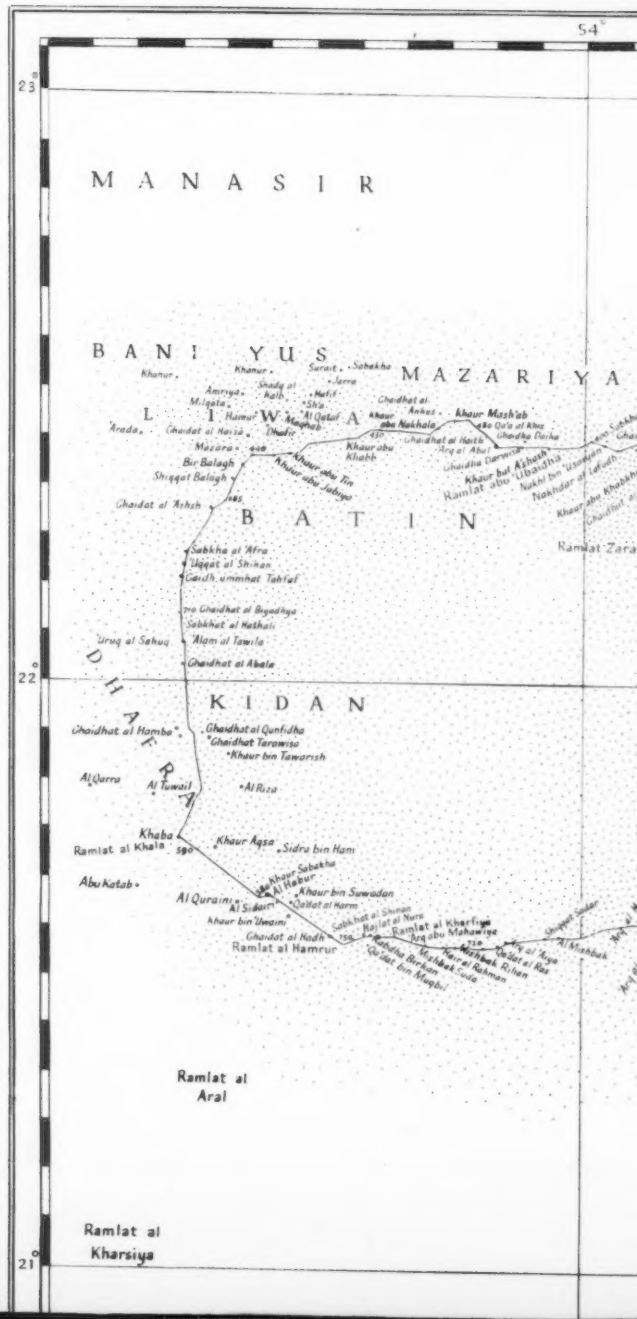
Paper: The geomorphology of Norway. By Dr. K. M. Strøm

The following were elected to Fellowship and Associate Membership of the Society on 15 March 1948:

Fellowship: Lt.-General Hasan Arfa; Norman F. B. Begg, B.SC.; Donald Herbert Blackeby, B.SC., L.C.P.; Richard Oswell Illtyd Borradaile; Adam Sebastian Brown; Henry David Butterworth, B.SC.; The Rev. D. S. Calver; Eric William Hunter Christie; Brian Fenton Dixon; John Benedict Eden; Miss Margaret Myra Evans; Derrick George Ferguson; Miss Marjorie Craven Findlay; Miss Alta Frances Fowler, B.SC.; David Elwyn Gibbs; John Gibbs; The Rev. Albert William Gordon; Dr. E. A. Gutkind; Ernest Percy Hart; James Frederick Hart; Donald Jack Hastings, O.B.E., B.A., B.SC.; Frederick George Higson, B.A.; George Fox Holmes; William James Robert Horsburgh; Harold Jackson; Nisith Ranjan Kar, M.SC.; Kenneth Earl Kidd, M.A.; Jacob M. Landau, M.A., F.R.A.S.; Miss Myrtle Lorna Ledgerwood; Captain John Murray Legg, O.B.E.; John Everson Lyne, M.A.; Commander John Hugh Mather, D.S.O., V.D., R.N.V.R. (ret.); John H. Matthews, B.A., B.SC.; Major Leonard Clifford John Moules; Eric Charles Palmer; Commander A. Payen, R.N.; Miss A. R. T. Prideaux, B.SC.; Miss Edwina Florence Agnes Shelton; Colin Percy Simpson; The Rev. Frederick H. Sterne; George William Sturges; Miss Margaret Sullivan; Philip Bradbury Tanner, M.A.; John Vanstone; Mrs. Dorothy Jane Ward; Paul Alexander Wilson; George Robert Wing

Associate Membership: Miss Frieda Barnett; Miss Constance Violet Benson; Miss Barbara Mary Cannon; Miss Nancy Elizabeth Drew; James Edward Ford Longman; Peter Charles Pratt; Miss Elizabeth M. Shepherd; John Gerald Simpson; Charles Russell Towns

Published July 1948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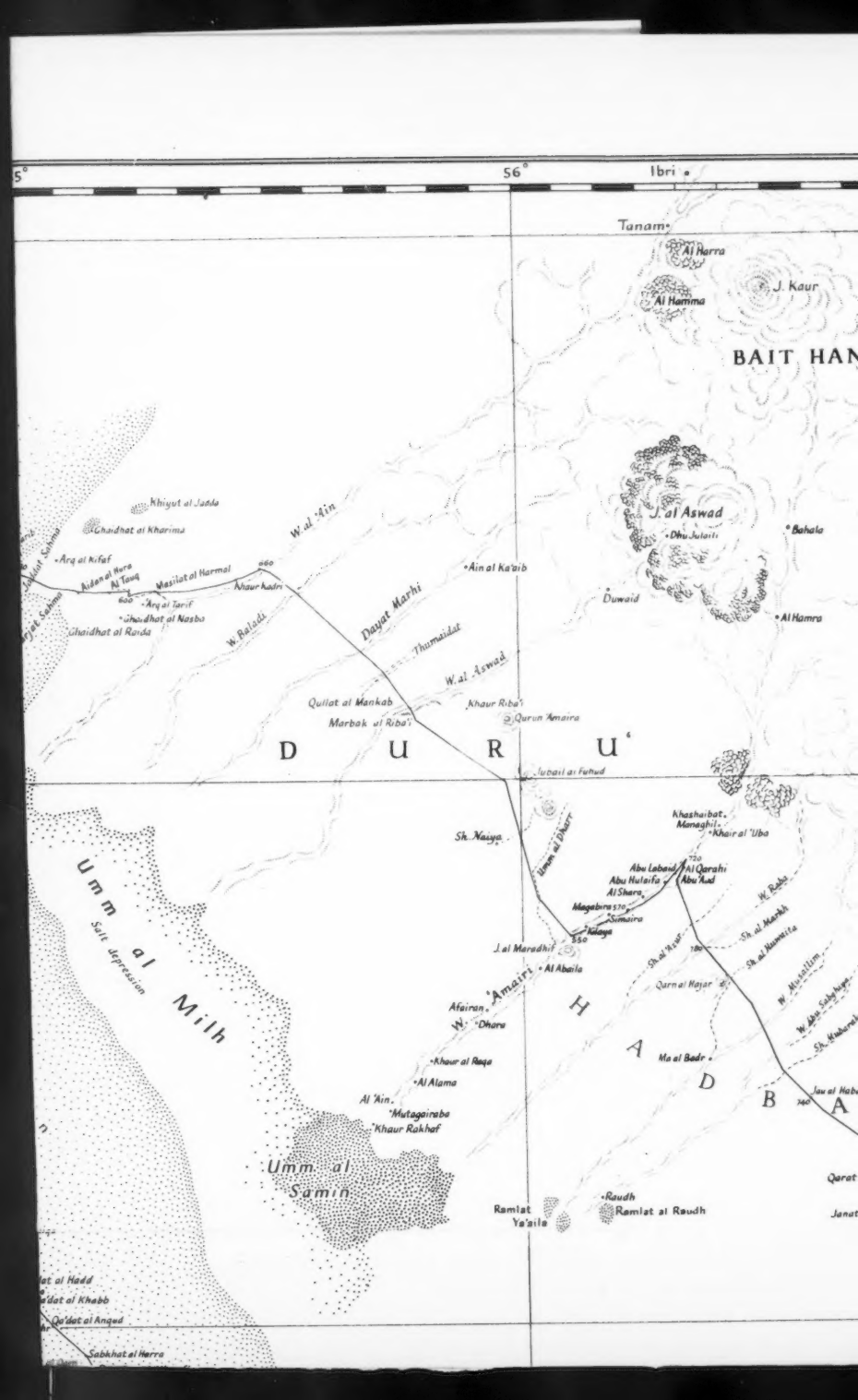
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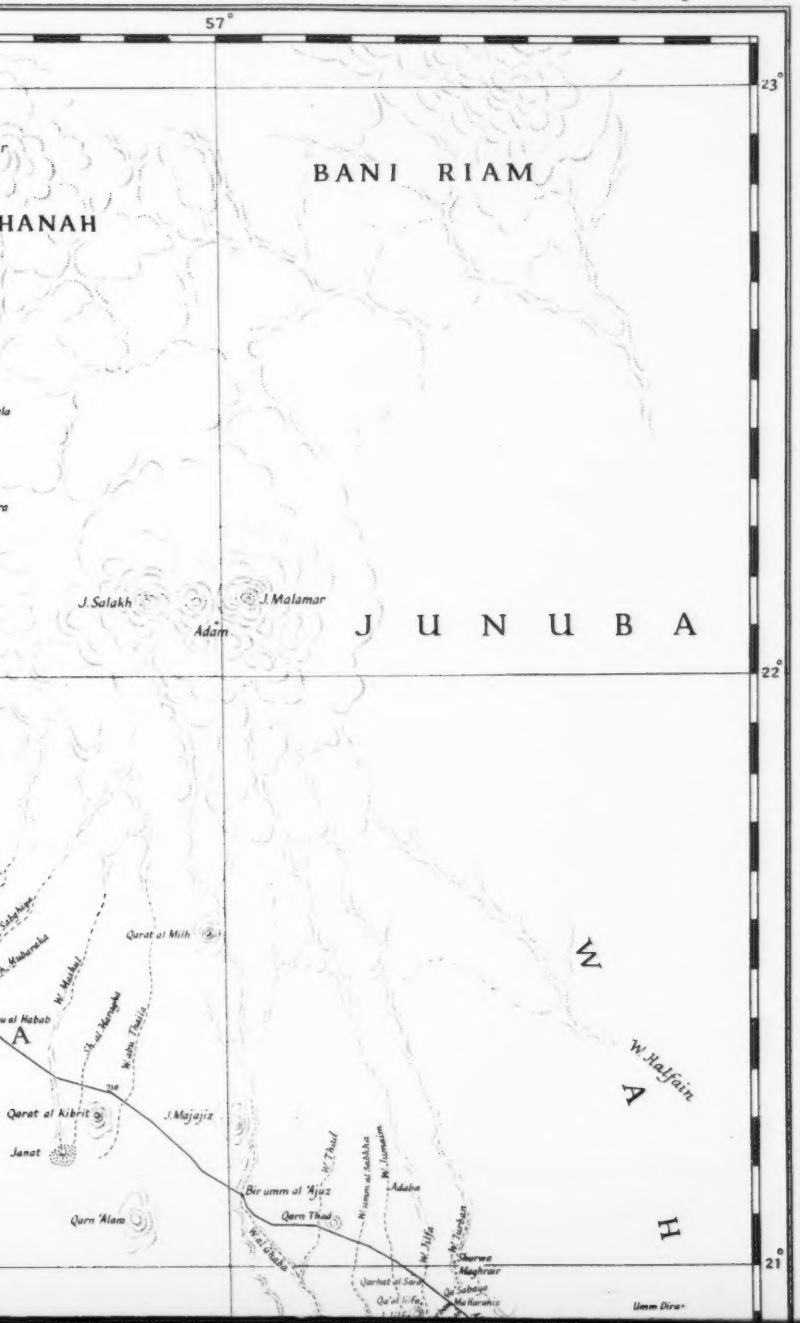
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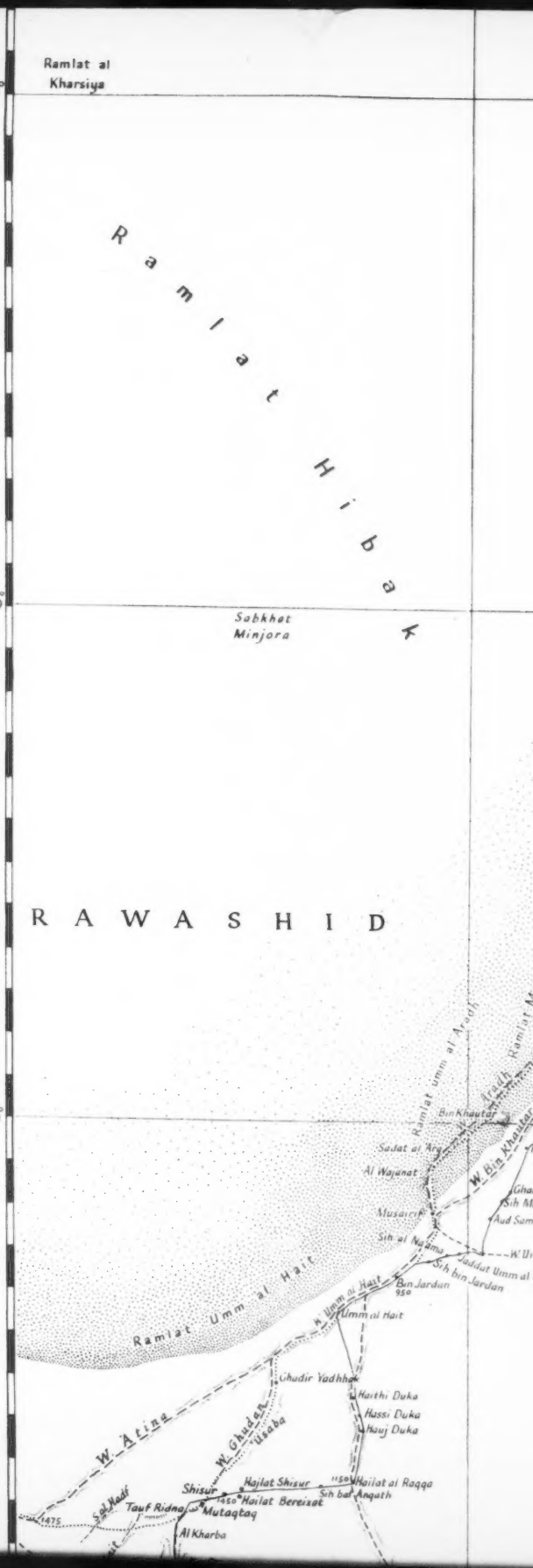
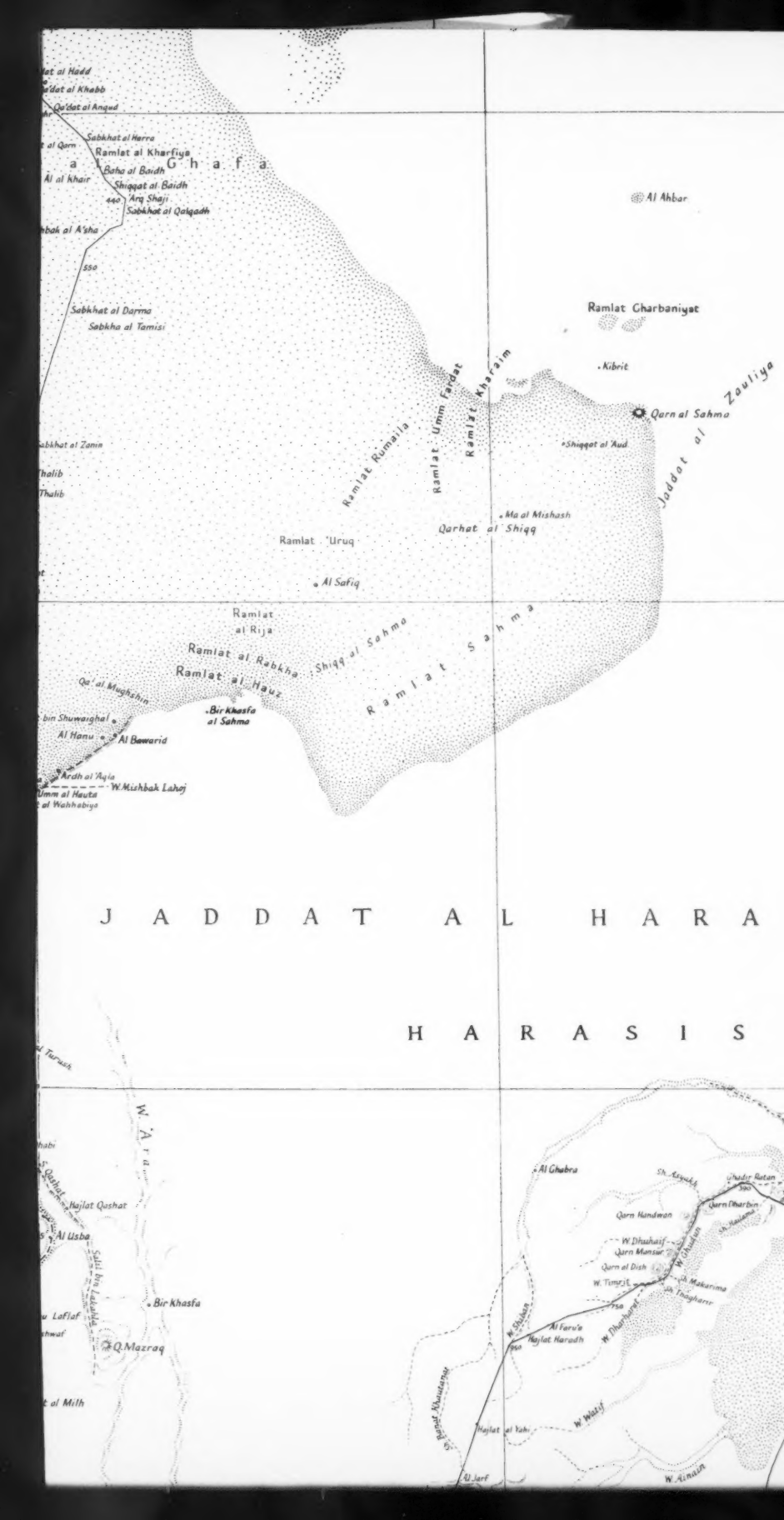
Qarn 'Alam
Sharwa
Maghrar
Umm Dira

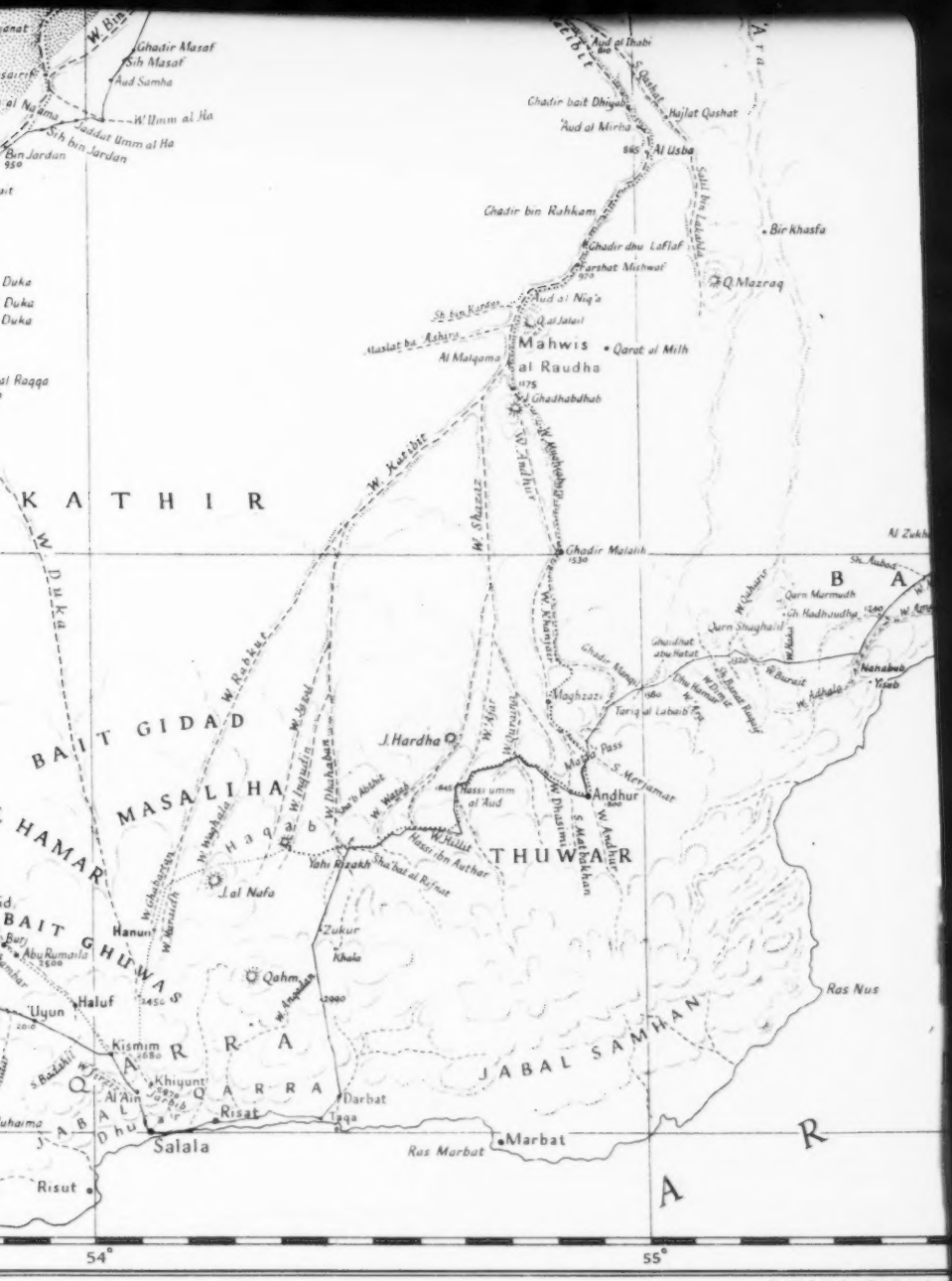

Ramlat al Kharsiya
21°
Ramlat Hiba
20°
Sabkhat Minjora
RAWASHID
19°
Ramlat Umm al Aradh
Bin Khautar
Sadat al Arg
Al Wajanat
W. Bin Khalkha
Musairib
Sih al Najma
Sih bin Jardan
Bin Jardan
950
Ramlat Umm al Hait
Umm al Hait
Ghudir Yadhhar
Haithi Duka
Hassi Duka
Hauj Duka
W. Atina
W. Ghudan
Usaiba
Hajlat Shisur
1150
Hailat al Raqqa
Shisur
1450
Hailat Bereisat
Sih bat Anqath
Sal Hait
Tauf Ridna
1475
Mutaqtaq
Al Kharba

Qa'dat al Hadd
Sabkhat al Darma
Qa'dat al Khabb
Qa'dat al Anqad
Sahmat al Bahr
Ghadhat al Qarn
Sabkhat al Harra
Ramlat al Kharfiya
Ramlat al Ghafa
Baha al Baidh
Arq Al al khair
Shiqqat al Baidh
Arq Shaji
Sabkhat al Qalqadh
Mishbak al A'sha
Sabkhat al Darma
Sabkha al Tamisi
Ramlat al Qalqadh
Sabkhat al Zamn
'Arq umm Chabir
Bir Thalib
Sabkha Thalib
Ramlat Rumaila
Ramlat 'Uruq
Al Safiq
Sabkha umm Fardat
Ramlat Huraidhiya
Ramlat al Rija
Ramlat al Rabkha
Shigg al Sahma
Ramlat al Hauz
Ramla
Al Qa'da
Khaur Bin 'Atarit
Ma'tarun
Umm Bala
Qa'dat Bin Karthur
Shiqqat umm al Shinan
Qa' al Mughshin
Bir Khasfa al Sahma
G H A F A
Al Hula
Ramlat Hula
Baludan
Ramlat Mafai
Khaur Mafai
Ramlat al 'Araqib
Shiqqat umm al Hadh
Abu Ghafa
Shiq umm al Tarafi
Khasfa
Ramlat umm al Arad
Bir al Sabkha
Umm al Tarafi
Quraishat bin Shumaighal
Al Hanu
Al Bawarid
Ramlat Khasfa
Ramlat Qarla
BAIT MUSAN
Bir al Qu'ai
Umm al Harm
Ramlat umm Dasis
Ma al 'Aqla
Ardh al 'Aqla
W. Mishbak Lahoj
Mandar al Mirakh
Umm al Hauta
Ramlat Yibla
Ramlat Mishash
Nakhdat al Chathid
Al 'Ain
Binat al Wakhabiya
Ramlat Ayma'
Nakhdat Buhaitan
Matki
Ramlat Mughshin
W. Mughshin
Al Kardafa
Marsaudid
Al Jari
Al Tauf
Al Barsa
Al Nughar
Mandar al Yahi
J A D D A T
Shiqqat al Audha
Umm al Maraha
Al Salam
Aidan al Qawafil
Sh. al Turush
Aidan al Shuyukh
Farshat al Jaidan
Yahi bin Marash
Tharjat Kathi
Ghadir Qadhra
W. Rafidit
Ghadir Masaf
Aud Samha
Aud al Dhabi
Ghadir bait Dhiyab
Hajlat Qashat
'Aud al Mirtha
Al Usba
W. Umm al Ha
Ghadir bin Rahkam
Bir Khasfa
Ghadir dhu Laflaf
Farshat Mishwaf
Q. Mazraq
Aud al Niq'a
Qa'at Jalail
Mahwis
Qaret al Milh
Al Malqama
al Raudha
Ghadhabdhab

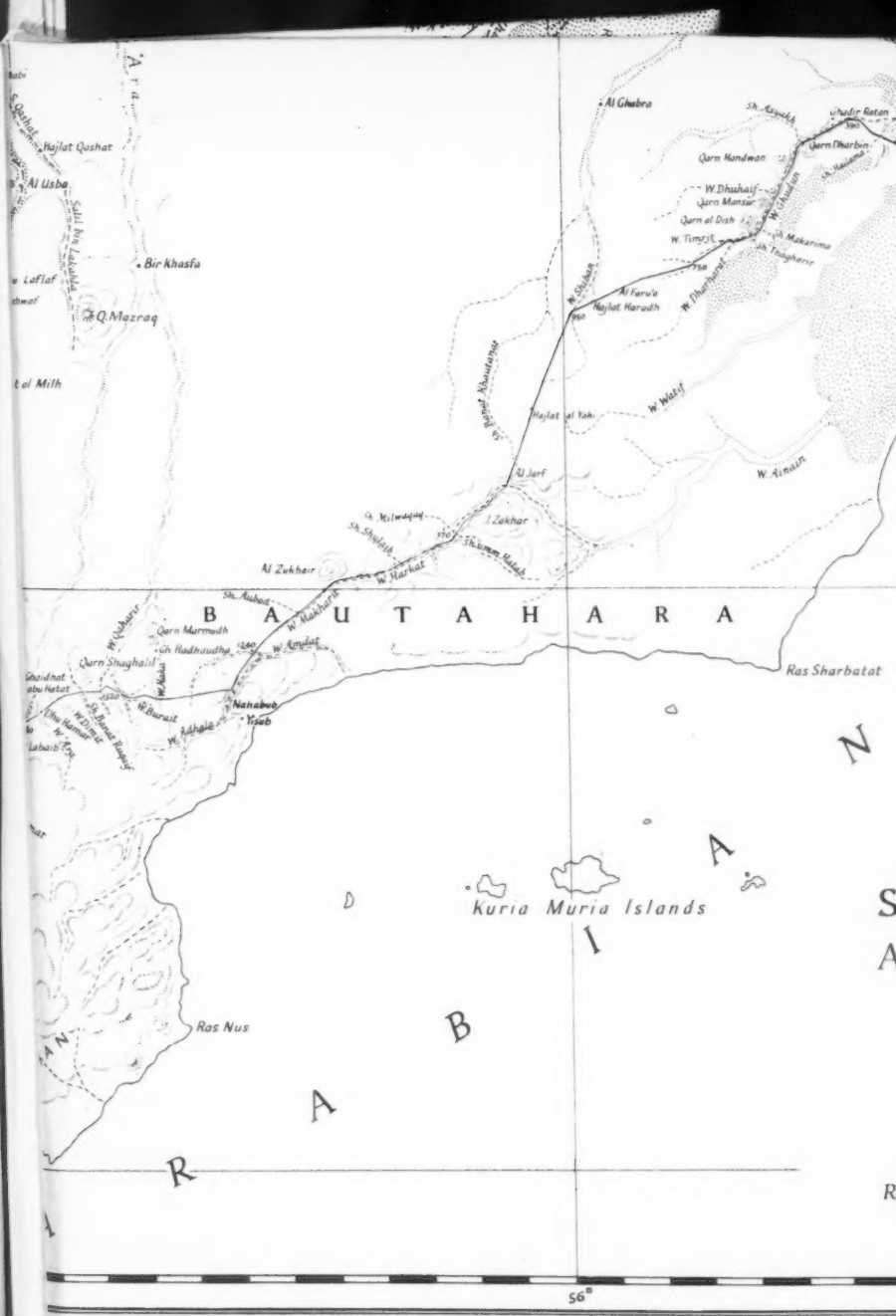

Ramlat al Kharfiya
Batha al Baidh
Shiqqat al Baidh
'Arq Shaji
Sabkhat al Qalqadh
Sabkhat al Darma
Sabkha al Tamisi
Al Ahbar
Ramlat Gharbaniyat
Kibrit
Qarn al Sahma
Shiqqat al 'Aud
Jaddat al Zauliya
Ramlat Rumaila
Ramlat Umm Fardat
Ramlat Kharaim
Ma al Mishash
Qarhat al Shiqq
Ramlat 'Uruq
Al Safiq
Ramlat al Rija
Ramlat al Rabkha
Shiqq al Sahma
Ramlat al Hauz
Ramlat Sahma
Qa' al Mughshin
Bir khasfa al Sahma
Al Hanu
Al Bawarid
Ardh al 'Aqla
W. Mishbak Lahoj
Umm al Hauta
JADDAT AL HARA
HARASIS
W. 'Ara
Hajlat Qashat
Al Usba
Bir Khasfa
Q. Mazraq
Al Ghubra
Sh. Arsukh
Qarn Handwan
Qarn Dharbin
W. Dhuhaisf
Qarn Mansur
Qarn al Dish
W. Timrit
Sh. Makarima
Sh. Tughurrir
Al Fara'a
Hajlat Haradh
W. Dhuhaisf
W. Shuhan
Hajlat al Yahi
W. Wabisf
W. Ajnain

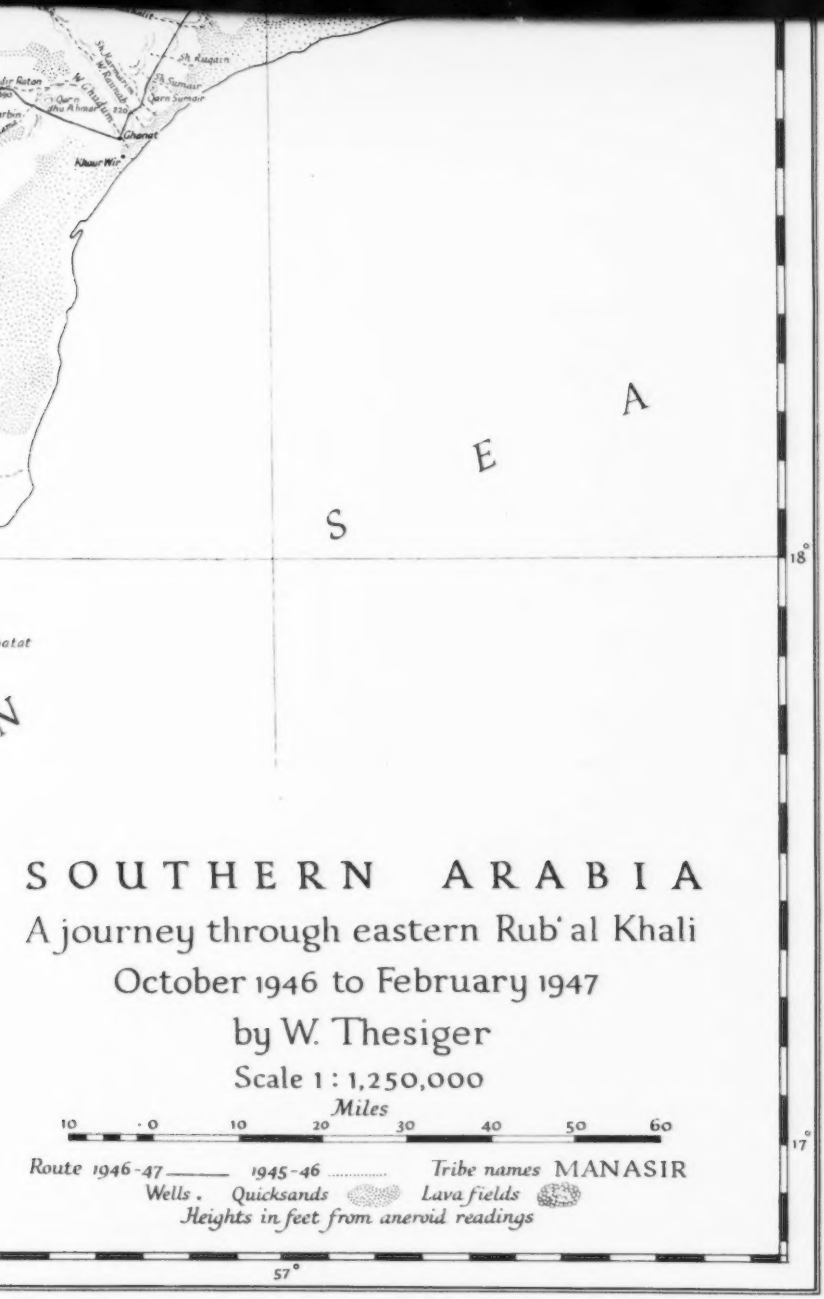
Qarn 'Alam
Bir umm al 'Ajuz
Qarn Thad
W. al Jaka
W. umm al
Adaba
W. Julfa
Shurwa Maghrur
Qarhat al Sara
Qa' Sabaya Ma Narahis
Qa' Julfa
Qa' Tarfa
Tarfa Farad
Al Jaraf
Qurun al Gharban
Qarn al Khum
Ilashi
110
Umm Dira
W. Marakhkha
Ramlat khawatim
Jarf al Nasj
Ghaidhat abu Zaina
Arq al Hubail
Qarn Mahatta Humaid
Ramlat al Kabsha
AL HIQAF
W. Jarra
Sh. Dharr
Qurun al Dharr
Ghaidhat al Nasj
270
Hishat Fara'
Maghawara Sauda
Umm al Qurad
Ramlat Saudat
Batin al Mahai
Bir al Shama
Tauf Jarra'
Ramlat al Mahala
W. Sumaina
Qarn bin Nawash
Tauf al Naun
360
J. Sumaina
Qarn al Aswad
Tauf al Naun
Batin al Mahalim
Qarn Thamila
'Anqir
Ruq'
Nakhlit
Qurun Saka
480
Al Qatr
W. Jinn al Salam
Tauf Saka
Qarn Tath
Abu Tath
Aqlat
Qa' Tath
Sh. abu Samara
Tauf
Tath
Tauf al Mutalabia
Umm al Sal
670
'Ain Hindi
W. Jarf
Asaran
'Ain Ma
Al Nakd
Bahama
Tauf Fardi
Ghar al Muhain
W. Nasla
Jumm Ruqah
Tauf Niq'a
Umm Ruqaf
W. abu Khawasha
J. Mazka Kabir
Bai
Khurqishif
W. Ashalat
W. Saraf
Banat Maxtanji
Aud al Naf'a
Hajlat Manasif
Shaja al Hufasya
650
Hajlat Zimqharat
Dhahir
W. Hasiam
Sh. al Kharratis
670
Sh. Bunat Zuraiq
Qabr bin Mariya
Makhsain
W. Nakhalit
Sh. Kuqain
Sh. Sumasir
Qarn Sumasir
W. Khaf Rumah
W. Chaf Hum
220
Qarn abu Ahmad
Ratan
Ghanat
Khaur Wir
Al Hiqaf
H I B A
A S I S
J U N U B A
A
21°
20°
19°

Compiled and drawn by K. C. Jordan



Published by the Royal G


Hajlat Qushat
Al Usba
Bir Khasfa
Q. Mazraq
Al Ghabra
Qarn Handwan
Qarn Dharbun
W. Dhuhaif
Qarn Mansur
Qarn al Dish
W. Timyit
Sh. Makarima
Sh. Taqhariir
W. Dharharaf
Al Faru'a
Hajlat Haruth
W. Shuhan
Hajlat Khuwaghas
Hajlat al Kah
W. Watif
Al Jarf
W. Ainain
Sh. Wilwaqiq
Sh. Shwaiib
Shuqum Halab
Al Zukhair
W. Harkat
W. Hakharit
Sh. Ashad
B A U T A H A R A
Qarn Marmudh
Sh. Hadhaudha
W. Rowdat
Qarn Shaghalil
W. Kabir
Ghaidnat abu Hatat
W. Hamimat
Sh. Buraut
W. Ishgie
Nahabub
Yaub
Ras Sharbatat
Kuria Muria Islands
Ras Nus
A R A B I A N S E A
56°
Published by the Royal Geographical Society



SOUTHERN ARABIA

A journey through eastern Rub' al Khali

October 1946 to February 1947

by W. Thesiger

Scale 1 : 1,250,000

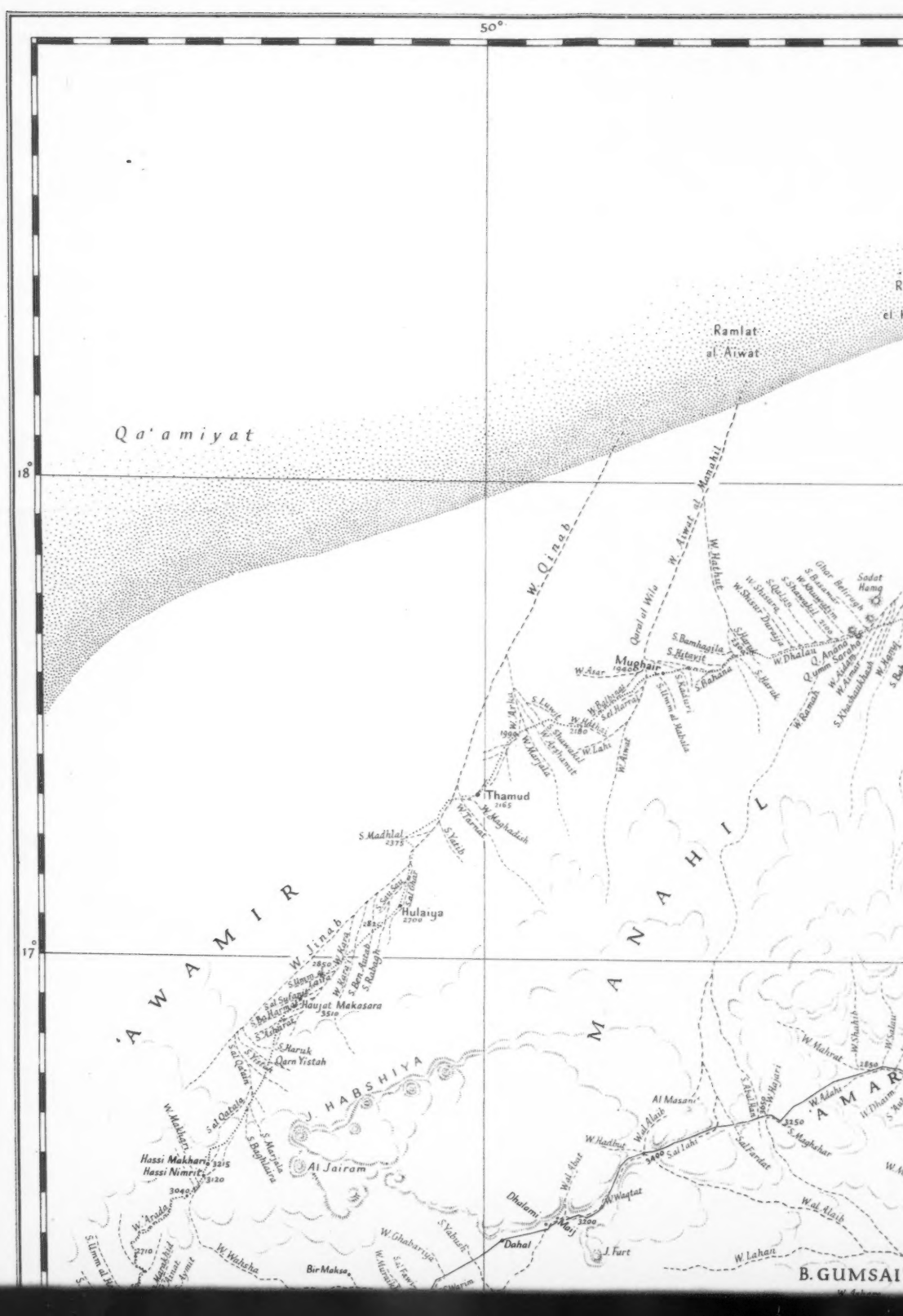
Miles

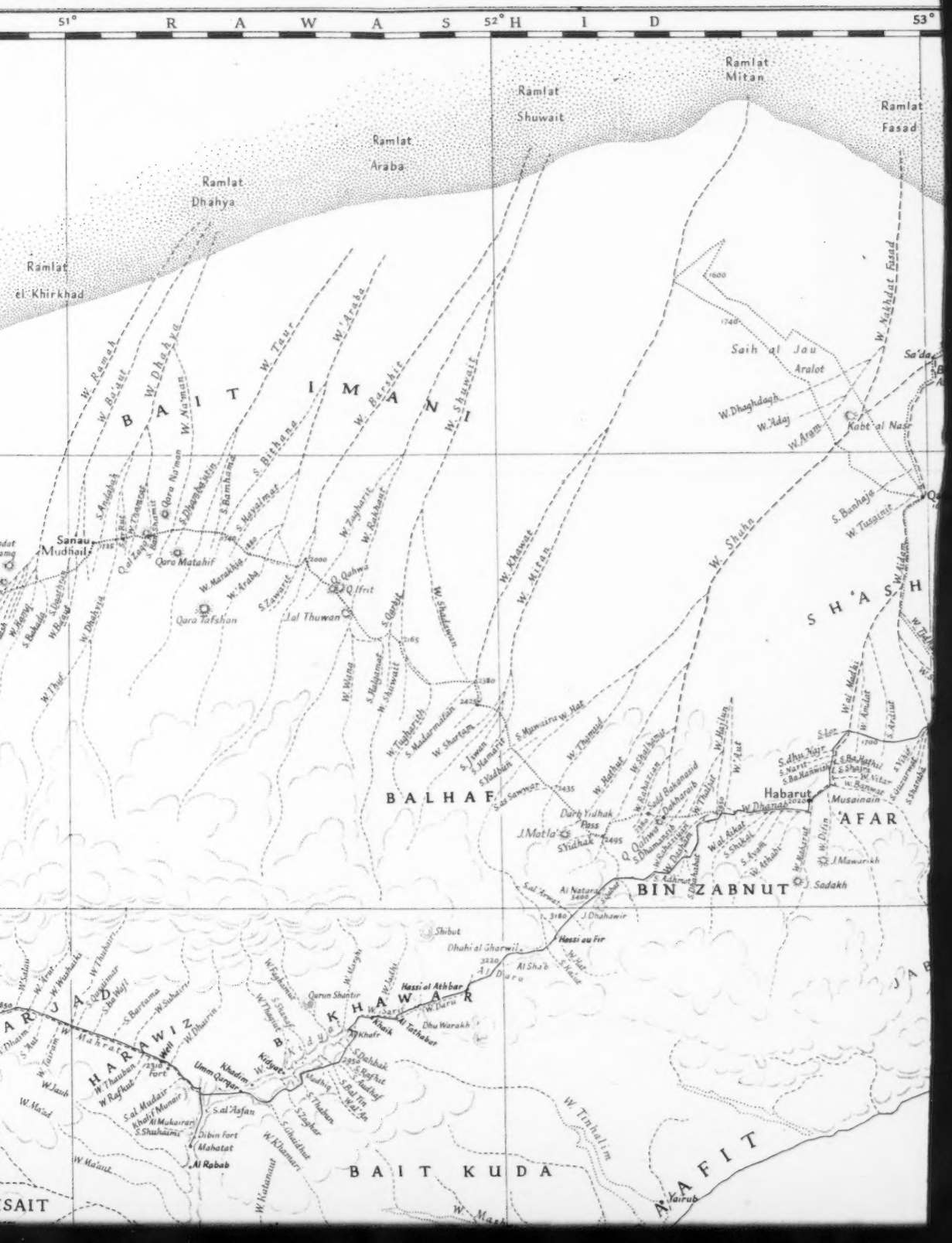
10 · 0 10 20 30 40 50 60

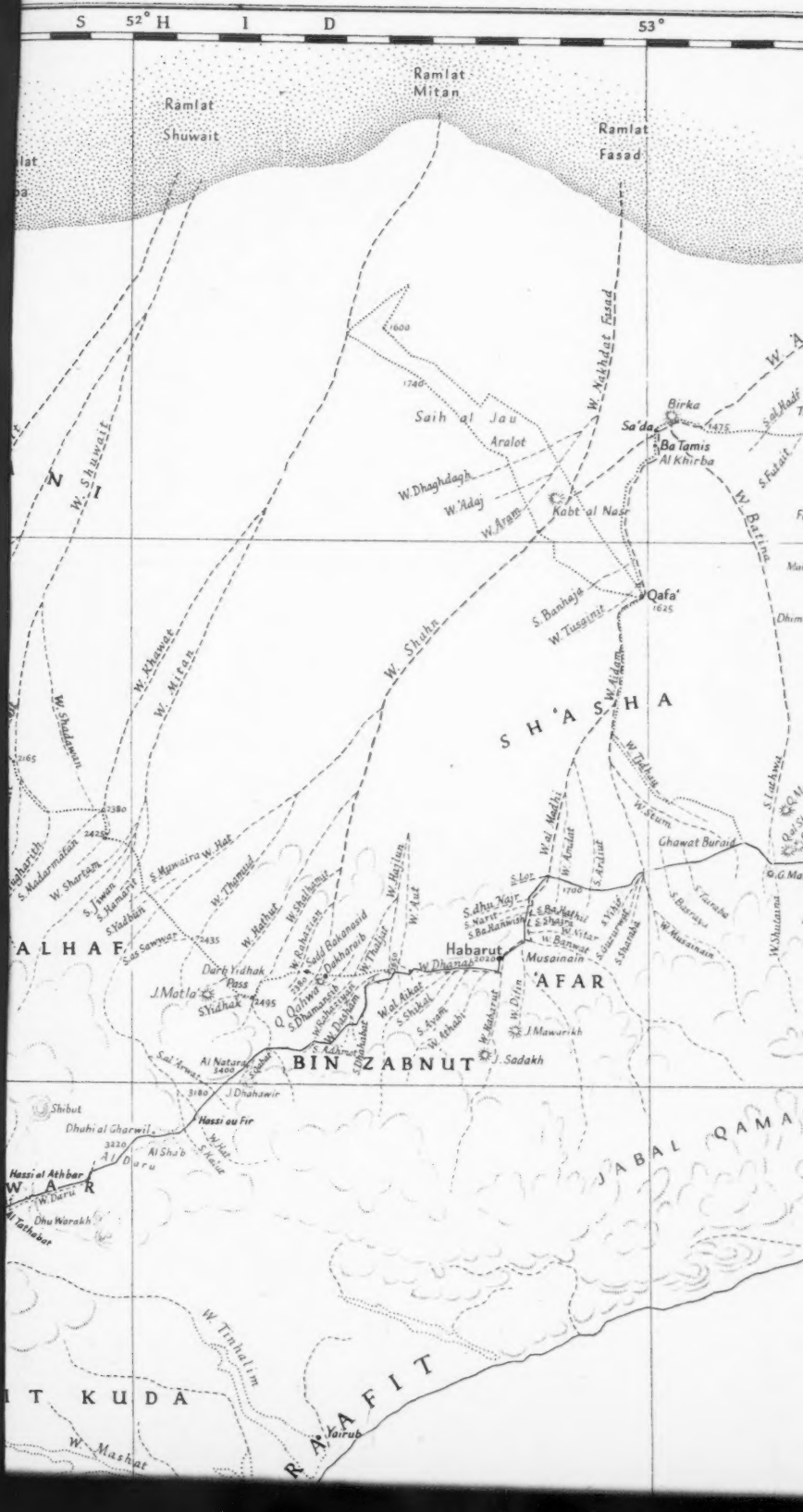
Route 1946-47 ——— 1945-46 ..... Tribe names MANASIR

Wells . Quicksands Lava fields

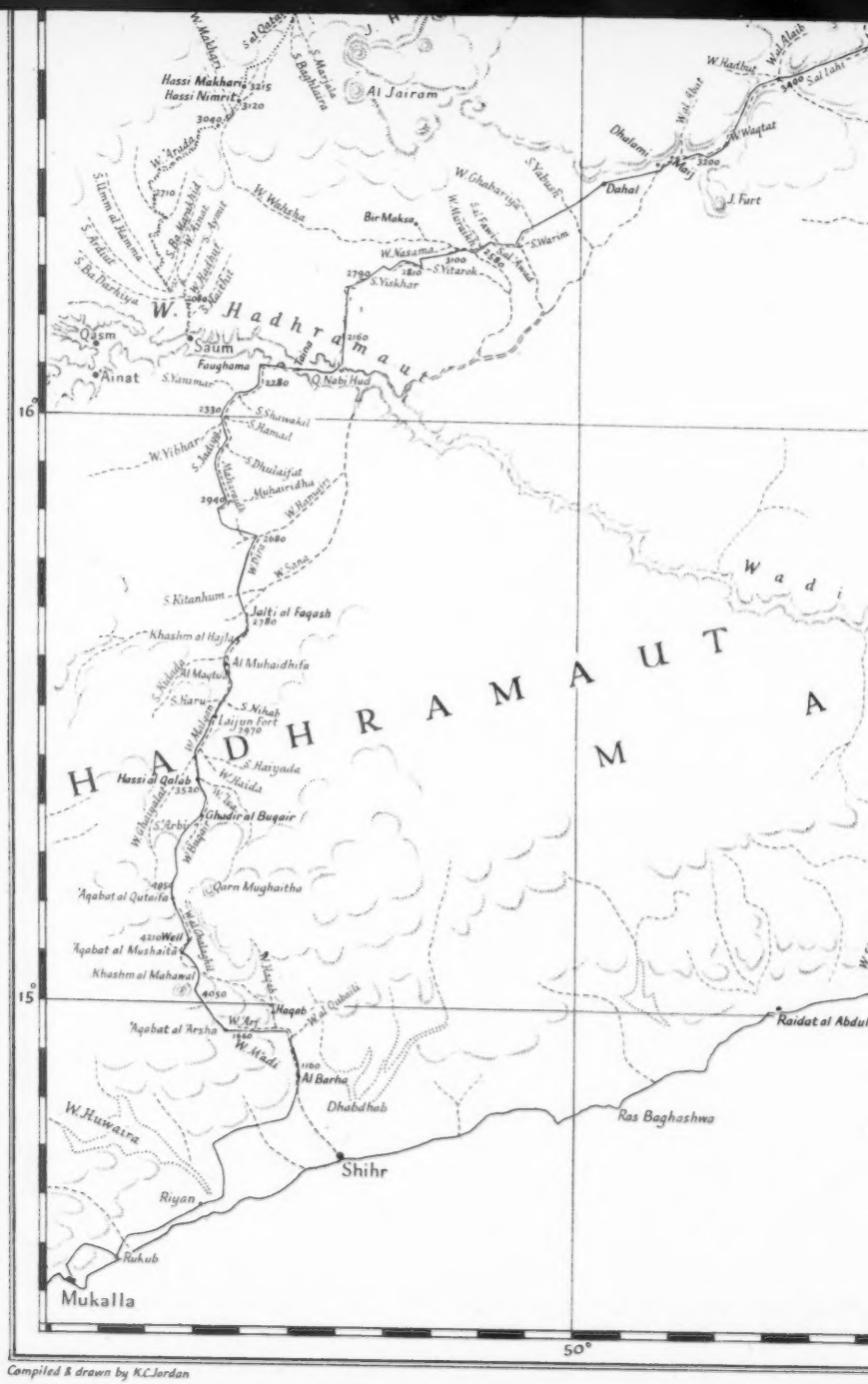
Heights in feet from aneroid readings


50°
18°
17°
Ramlat
al Aiwat
Qa'amiyat
W. Qinab
W. Aiwat al Mangubil
W. Hatibat
Qurad al Wilu
Mughair
W. Asar
S. Bamhasila
S. Hutayit
S. Rahana
S. Haruk
S. Kaluri
W. Dhalau
Q. Anang
Q. Qam Sarah
W. Ramah
W. Ajmah
W. Abdah
S. Khashkhash
Thamud
2165
W. Farmat
W. Maghaskah
S. Madhlal
2375
S. Yarb
W. Jinab
Hulaiya
2700
'AWAMIR
MANAHIL
JHABSHIYA
Hauyat Makasara
3510
S. Haruk
Qarn Yistah
S. al Qatela
W. Mahbah
Hassi Makhari
3215
Hassi Nimrit
3120
3040
Al Jairam
W. Arudda
2710
W. Washsha
Bir Makso
W. Ghabariya
S. Yahaf
Dahal
Dhalami
3200
W. Waqtat
W. al Ghat
W. Hadhut
W. al Alaib
3400
S. al Lahi
Al Masani
3250
S. Maghahar
Sal Farafat
W. Hajeri
W. Madrut
W. Shahin
W. Adahi
2850
W. Dhaim
'AMAR
J. Fart
W. Lahan
B. GUMSAI

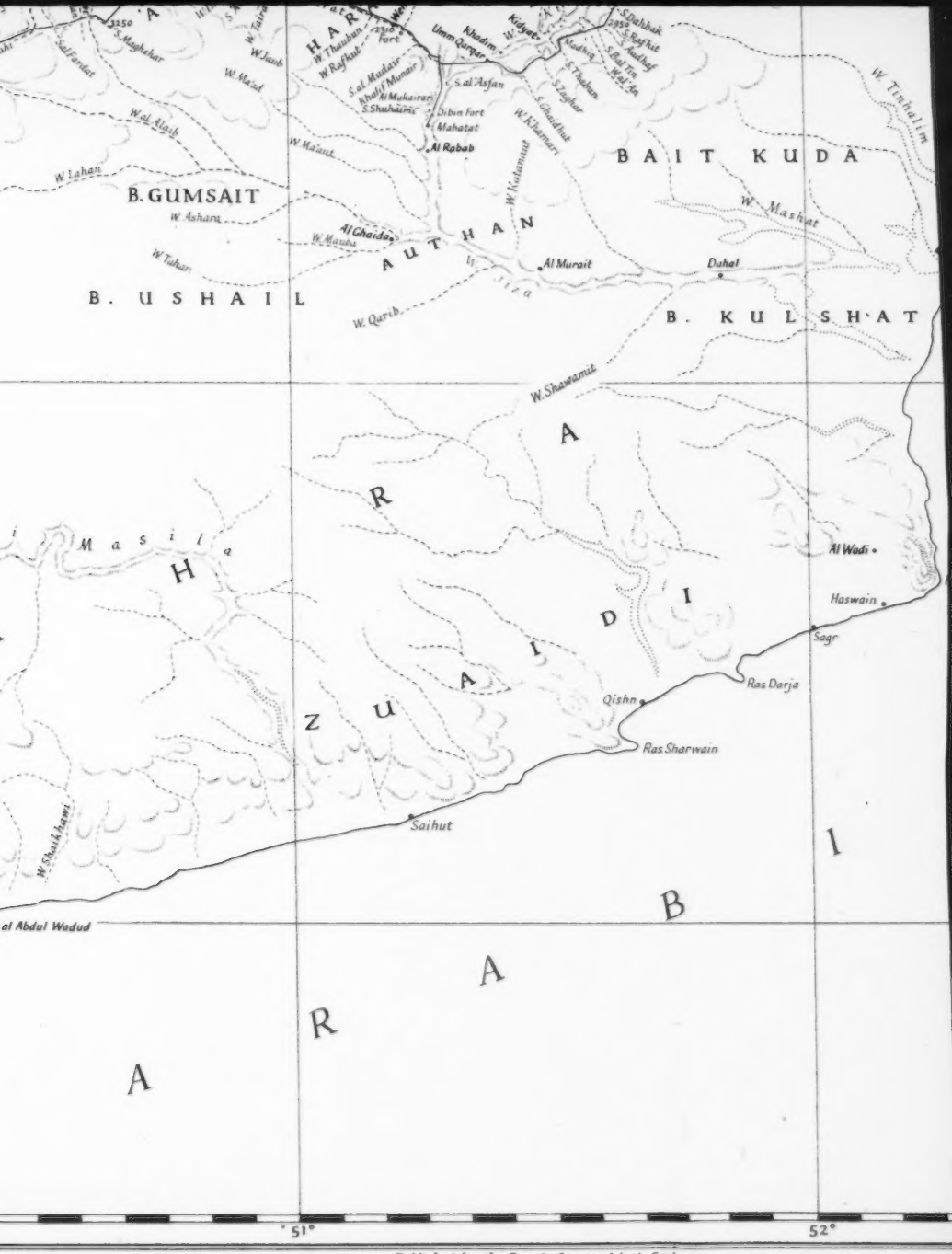

51°
RAWAS
52°
HID
53°
Ramlat Mitan
Ramlat Shuwait
Ramlat Fasad
Ramlat Araba
Ramlat Dhahya
Ramlat el Khirkhad
BAITIMANI
W. Ramah
W. Ba'ayat
W. Dhahaya
W. Na'man
W. Taur
W. 'Araba
W. Barshat
W. Shuwait
W. Nakhdat Fasad
Saih al Jau
Aralot
W. Dhaghdagh
W. 'Adaj
W. 'Aram
Kabt al Nas
Sa'da
S. Anabeh
Qara Na'man
S. Bitbana
S. Ramhana
S. Hajalmat
W. Zaghariz
W. Akhbaat
S. Banhaja
W. Tasgnir
Sanau
Mudhail
Qara Matahif
W. Marakhia
W. Kraba
S. Zawarit
Qara Tafshan
Jal Thuwan
Q. Qahwa
Q. Jfrit
S. Qarbat
W. Shadawan
W. Khawat
W. Mitan
W. Shuhn
SH'ASH
W. Dhahaya
W. Thuf
W. Wyna
S. Hajalmat
W. Shuwait
W. Tagharith
S. Madarmadan
W. Shartaan
S. Jiwan
S. Hamarit
S. Wadhan
S. Mawairu
W. Hat
W. Thamud
W. Hathat
W. Shalbaur
W. Tasbuhat
W. Hajilan
W. Kaf
W. Wal Maidi
W. Andalat
S. Ariaat
S. Lor
S. Abu Najr
S. Marit
S. Ba Nawwas
S. Ba Hathal
S. Shajra
W. Nitar
W. Banwat
S. Shurumat
S. Shaiaha
BALHAF
Habarut
Musainain
AFAR
Dirh Yidhak Pass
J. Matla'
S. Yidhak
Q. Qahwa
S. Dhamanit
W. Dhamar
W. Dhanga
W. Wal Atkat
S. Shikat
S. Ayam
W. Athabit
W. Habarut
W. Dibin
J. Mawarikh
J. Sadakh
Sal Arwan
Al Natarah
BIN ZABNUT
J. Dhahawir
Hassi au Fir
Shibut
Dhahi al Sharwil
Al Sha'b
Al Diaru
W. Hat
Hassi al Athbar
W. Faghamani
W. Marghi
W. Jadhi
W. Dhaim
Dhu Warakh
Qurun Shantir
W. Thuqiut
S. Shanif
BARJAD
KHAWAR
Khaik
Al Tathaber
Khafr
W. Sabrin
W. Dhurin
W. Subarin
S. Bartama
S. Qarsimar
Ba Hajl
W. Thukhair
W. Wushaiks
W. Kraf
W. Yashkur
W. Thaiban
W. Rafkhat
Mahrat
HARAWIZ
Well
Fort
Khadim
Kidyat
S. Dahbak
S. Rafhat
S. Radhaf
S. Wal'da
S. Radhfa
S. Thaiban
S. Zaghar
S. Jabadhat
W. Khamsari
W. Katanaut
W. Jauh
W. Malaut
S. Mudair
Khalf Munair
Al Mukairari
S. Shuhaimi
S. al 'Asfan
Dibin Fort
Mahatat
Al Rabab
BAIT KUDA
W. Tinhalim
AFIT
A'Yairub
W. Mash
ESAIT


S 52° H I D 53°
Ramlat Mitan
Ramlat Shuwait
Ramlat Fasad
Saih al Jau
Aralot
W. Nakhdat Fasad
Birka
Sa'da
Ba Tamis
Al Khirba
W. Dhaghdagh
W. 'Adaj
W. Aram
Kabt al Nas
W. Shuwaif
W. Khawat
W. Mitan
W. Shadawn
W. Shdhn
Qafa'
1625
S. Banhaja
W. Tusaimir
W. Barina
SH'A SHA
W. Aidam
W. Dahwa
W. Sturm
Ghawat Burair
W. Hatbat
W. Thumud
W. Shallamur
W. Hajiun
W. Aat
W. al Hadhi
W. Andalat
S. Ardiat
S. Lor
S. Dhu Najr
S. Narir
S. Ba Hathal
S. Ba Rahaish
S. Shajra
W. Nitar
W. Banwat
Musainain
S. Vihar
S. Shurumbat
S. Sharoka
S. Zarraba
S. Basraka
W. Hussainain
W. Shutaima
Habarut
1020
W. Dhanab
AFAR
ALHAF
Dark Yidhak Pass
J. Matla'
S. Yidhak
2495
Q. Qahwa
S. Dhamanab
W. Dashkam
W. Thalilat
W. Dahariyan
W. Bahariyan
Sadd Bakonasid
Wal Ankat
S. Shikal
S. Ayam
W. Ethahi
W. Hadarud
W. Dirin
J. Mawarikh
J. Sadakh
BIN ZABNUT
Al Natarna
3400
Sal 'Awaz
S. Dhahawir
J. Dhahawir
3180
Shibut
Dhuhi al Gharwil
3220
Hassi au Fir
Al Sha'b
Al Duru
W. Hatat
S. Kaiwa
Hassi al Athbar
W. Daru
Dhu Warakh
Al Tathaber
W. Tinhalim
JABAL QAMA
T KUDA
RA'AFIT
Yairub
W. Mashat

54°
Ghadir Masaf
Sih Masaf
Aud Samha
Musairih
Sih al Nagma
W Umm al Ha
Jaddat Umm al Ha
Sih bin Jardan
Bin Jardan
950
Sih Umm al Hait
Umm al Hait
Ramlat Umm al Hait
Ghudir Yadhhak
Harthi Duka
Hussi Duka
Hauj Duka
W Ghudan
Uraba
W Atina
Hajlat Shisur
1150
Hailat al Raqqa
Sih bat Anqath
Shisur
1450
Hailat Bereizat
Tauf Ridna
Mutaqtaq
Sal Hadf
Al Kharba
Naufit
BAIT KATHIR
Futait
Sih Ba Niza
W Duka
18°
Sih Jarbadh
Muhtadat
Sih Ba Charban
Al Burj al Saliya
Dhimir Ghara
Sih Barqat
Daqua
Maghadhi
Sih Raina
Sih Bubaina
W Ghudan
1580
W Ghafra
W Radhkat
BAIT GIDAD
MASALIHA
BAIT AL HAMAR
Al Kharba
Al Thalu
W Haluf
W Ghubaizan
W Hashfala
Jal Nafa
Mudhail
1615
Ma Shadid
W Madhkra
Burj Abu Rumaila
2599
Hanun
BAIT GHUWAS
Al Ghail
1750
W Mirie
Dhamhar
Uyun
2010
Haluf
2450
Kismim
2680
ARRA
Khiyunt
2970
2778
Al Ain
3 F
Risat
17°
Ruhaima
JABAL DHU
Salala
Risut
Ras Sajar
MAR



Compiled & drawn by K.C.Jordan



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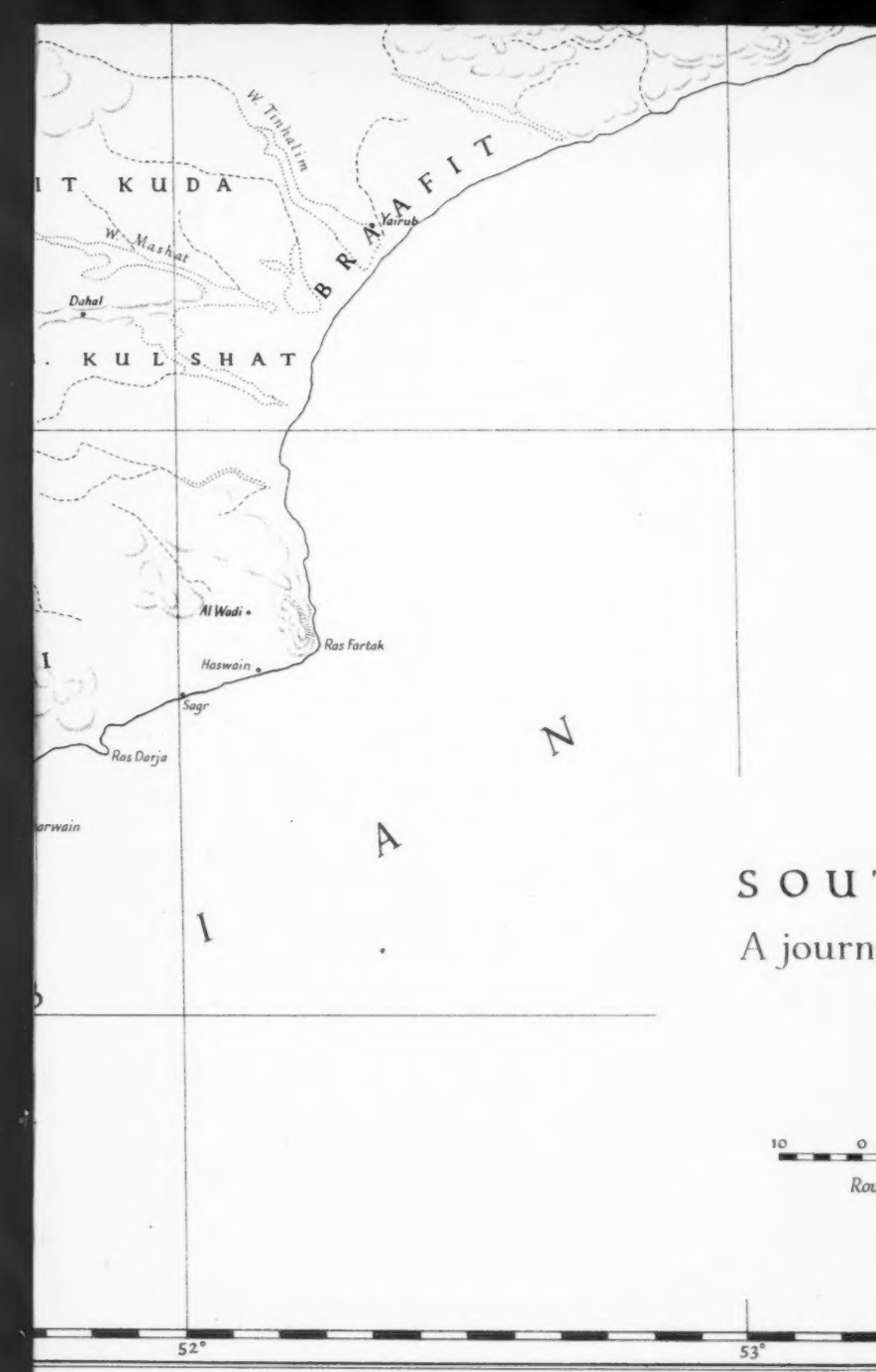
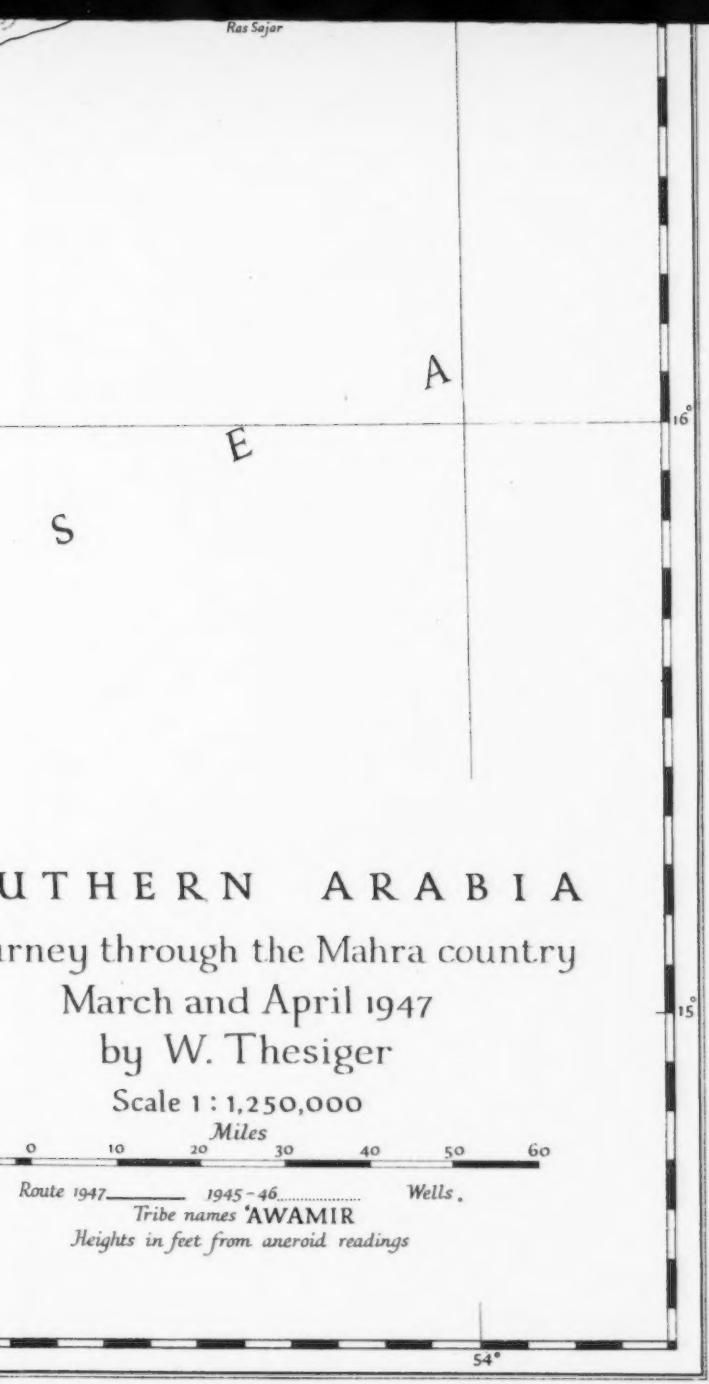

W. Tinhelim
I T KUDA
W. Mashat
Yairub
BRAFIT
Duhal
. KUL SHAT
Al Wadi
Ras Fartak
Haswain
Sagr
Ras Darja
arwain
N
A
I
SOU
A journ
10
0
Rou
52°
53°
ty



UTHERN ARABIA

rney through the Mahra country
March and April 1947
by W. Thesiger

Scale 1 : 1,250,000

Miles

0 10 20 30 40 50 60

Route 1947 _____ 1945-46 ..... Wells.

Tribe names 'AWAMIR

Heights in feet from aneroid readings